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CHEMICAL PEELING OF FRUITS, I
SANTOL [SANDORICUM KOETJAPE (BURM. F.) MERR.]

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ONE TEXT FIGURE

Food, like fine chemicals, must be processed with care. Contamination of chemicals by traces of elements and compounds from the equipment and from other sources may happen during the processing; similarly, food may be contaminated by the presence of elements that would reduce the food value or cause the loss of materials vital to health. Contamination can be avoided through the proper selection of raw materials, the use of proven processing techniques, and through other ways.

One of the unit operations in food processing which requires care is the removal of all inedible portions, particularly the skin or "peel" of the fruit. Removal of the peel is a problem, especially if the surface of the fruit is very irregular.

METHODS OF PEELING FRUITS

In fruit processing, the removal of the skin may be accomplished by any of the following methods:

Peeling by abrasion.—This method is extensively used for peeling potatoes, carrots, parsnips, sweet potatoes, turnips and the like. The resultant wastage by the use of an apparatus is rather high and considerable hand trimming is also required.

Peeling by steam.—This process is also used for halved and pitted peaches, beets, potatoes, sweet potatoes, tomatoes, carrots, pimentos, etc. The materials are arranged in trays and placed in a steam box for 2 to 3 minutes. The steam loosens the skin sufficiently to be easily slipped from the fruit by hand. Beet roots are steamed in a retort at 220°F for 20 to 25 minutes, then chilled in water and trimmed and peeled by hand. Potatoes and other root crops of the same genus are peeled by placing the crated root crops in a retort heated at 240°F for 9 to 12 minutes and removing the skin by hand.

Peeling by hot water.—This process is also used for peaches in halves, tomatoes and citrus fruits. The materials are alternately immersed in hot and cold water. The skin is thereby loosened as in the steam method and is easily removed. The hot water method is preferred over steam method owing to the uniform heating and cleaning action of the water. The loosened skin is removed by hand as in the steam process.

Peeling by chemicals.—This method is of ancient origin. Olive has been treated with lye, ashes and quicklime for centuries, the object being to remove the bitterness of the fruit. No better method has as yet been developed to take the place of the old one.

According to literature, the North American Indian used wet ashes or the water in which the ashes had been soaked to remove the hull from the grains of corn long before the white man came to America. The lye-peeling method was used in the production of hominy, where the corn was peeled with wood ash leachings. The corn was boiled with the lye until the skin could be slipped off from the kernels by the fingers and cleansed further by washing in running water. This process has been improved upon by the Americans for which several patents have been issued consecutively. One of these was issued as early as 1901 for treating prunes to facilitate drying. Another was issued to Thompson(7) for the use of a lye bath for disintegrating the skin of certain fruits. In 1922 Dunkley(2) was granted a patent for a caustic alkali spray procedure. Taylor in 1929 was issued another patent for the use of boiling aqueous solution of sodium chloride and sodium bicarbonate for the removal of the skins of potato tubers and other root crops and vegetables.

In food industries, lye peeling is an established procedure. Woodruff(8) described the skinning of peaches by immersion

in 10 per cent lye for 3 to 5 minutes at 140°F. The peel was then rubbed off, the peeled fruit washed in cold running water, then passed through a 2 per cent citric acid and/or 0.1 per cent hydrochloric acid. The acid treatment brought back the normal acid value and prevented discoloration.

Chemical peeling had been practiced for quite sometime and the work of Olsen(6) on peaches drew added attention on the process. Olsen further used wetting agents to shorten the time of treatment. He reported a reduction of as much as 65 per cent in the time required to peel peaches by the addition of such adjunct. For the rapid peeling of potatoes, Mazzola(5) advocated the use of lye concentrations up to 53 per cent and temperatures up to 300°F.

Lankler and Morgan(4) reported carrots had been processed at the rate of 350 tons in 24 hours. The peeling have been effected by immersion in 5 per cent lye for 2 to 2⅓ minutes at 212°F. The peelings were removed by means of high pressure rotary spray washers. It would not have been possible to peel that amount economically by hand. A western U.S. plant which dehydrates 750,000 lbs. of potatoes daily was mentioned by the same authors to have employed lye peeling in order to save 50 per cent to 60 per cent of the edible product. Lye peeling of Vee Type Freestone Peaches had also been tried in 1957 by Atkinson and Kitson(1) with remarkable success in the way of reducing handling cost of peaches, and increasing production by making labor available for other sections of the canning line.

The lye-peeling method has been found to be cheaper, more rapid and less wasteful than the other methods. The disadvantages are: (*1*) the peeled fruit may become brown on storage; and (*2*) the flesh itself may be attacked if the fruit is allowed to lie immersed in lye too long.

Lye peeling is based on the fact that caustic alkali solution attacks the cuticular tissues and causes their dissolution. To be effective the dissolution must be rapid; the tissues affected must be promptly removed by washing to minimize attack on the flesh; and, above all, the process must be economical and efficient.

This process is specially adapted to fruits having very irregular surface and/or small fruits where hand peeling will be too laborious.

PEELING OF SANTOL

That caustic peeling had ever been tried on santol fruit has not been shown by the literature. At present, santol fruit for immediate consumption and/or proservation is peeled by hand with a knife. The process is not only time-consuming but wasteful, and the need for an efficient time- and pulp-saving method is obvious. The present study deals with the peeling of ripe santol fruit through the use of lye.

EXPERIMENTAL PROCEDURE

The fruit was selected for uniformity in ripeness, since ripeness is believed to have an important bearing on peeling time. A trial run has shown that green fruit can be peeled with either the immersion time extended and the lye concentration increased or the temperature raised.

Peeling experiments were conducted with at least a liter of test solution in a two-gallon enamelled pail. The fruit was immersed in the solution and part of the lot removed at intervals.

The skin was rubbed off by hand under cold running water. The peeling time reckoned was the length of time necessary to effect an easy and complete skin removal.

In subsequent trials, the fruit was first soaked in hot water then immersed in the lye solution.

Determination of right concentrations of sodium hydroxide.—Solutions of sodium hydroxide of varying concentrations were prepared. The solutions were then heated to boiling point. The concentrations of the solutions ranged from 0.5 per cent, with half per cent increases, to 8.0 per cent. The fruit was then immersed in the solutions and later removed after various lengths of time to determine the degree of peeling. The results are shown in Table 1.

Determination of right lengths of exposure in different concentrations of sodium hydroxide.—Solutions of sodium hydroxide at concentrations of 5 per cent, 6 per cent, 7 per cent, and 8 per cent were heated at temperatures of 140°F and 200°F. The fruit was dropped into the lye solution, which was kept at either 140°F or 200°F, and removed after immersions from one minute to 6 minutes. The peel was removed by rubbing the fruit under water with the hands. Table 2 shows the results of the trial.

TABLE 1.—*Effect of different concentrations of sodium hydroxide and varying lengths of immersion on the peeling of santol fruit at approximately simmering-to-boiling temperature.*

Concentration of sodium hydroxide	Length of immersion	Observations
Per cent	*Minutes*	
0.5	5	did not peel off
1.0	5	- do -
1.5	5	- do -
2.0	5	- do -
2.5	5	- do -
3.0	5	just starting to peel off
3.5	5	partial peeling
4.0	1	- do -
4.0	2	not fully peeled
4.0	3	cleaner than 2 minutes at 4.0 per cent
4.0	4	almost peeled completely
4.0	5	peeled off rather thinly
5.0	1	peeled off thinly with patches
5.0	2	peeled off but not uniformly
5.0	3	better than 2 minutes at 5.0 per cent
5.0	4	complete peeling
5.0	5	completely peeled off, fruit softened
6.0	1	peeled off but not thorough
7.0	1	peeled off but not complete
8.0	1	- do -

TABLE 2.—*Effect of different concentrations of sodium hydroxide, different temperatures, and varying lengths of immersion on peeling of santol fruit.*

Concentration of lye	Temperature	Length of immersion	Observations
Per cent	°F	*Minutes*	
5.0	200	1	Only the surface peeled off, discolored.
		2	Same as for 1 minute.
		3	Peeled off with sufficient rubbing, no discoloration.
		4	Peeled off easily, no discoloration.
		5	Peeled off easily, fruit softened, no discoloration.
		6	Peeled off easily, fruit soft, no discoloration.

TABLE 2.—*Effect of different concentrations of sodium hydroxide, different temperatures, and varying lengths of immersion on peeling of santol fruit.—Continued.*

Concentration of lye	Temperature	Length of immersion	Observations
Per cent	°*F*	*Minutes*	
6.0	140	1	Did not peel off.
		2	Only part of the surface peeled.
		3	Peeled with rough rubbing, discolored after peeling.
		4	Peeled with less rubbing, no discoloration.
		5	Peeled almost completely, no discoloration.
		6	Peeled about completely, no discoloration.
6.0	200	1	Only the surface peeled off, discolored.
		2	Like the one minute treatment.
		3	Peeled off by rough rubbing, no discoloration.
		4	Peeled off rather easily, no discoloration.
		5	Peeled off easily, no discoloration but fruit soft.
		6	Similar to the 5 minutes period.
6.0	200	4	Peeled off rather easily, no discoloration.
			Peeled off easily, no discoloration but fruit soft.
			Similar to the 5 minutes period.
7.0	140	1	A thin part of the surface removed, discolored.
		2	A thin portion of the peel removed and discolored.
		3	Almost completely peeled but requires hard rubbing.
		4	Peeled off as in 3 minutes but with less rubbing, no discoloration of the cleaned surface.
		5	Peeled off completely but fruit is soft and had no discoloration.
		6	Same as in 5 minutes, but fruits were soft.

TABLE 2.—*Effect of different concentrations of sodium hydroxide, different temperatures, and varying lengths of immersion on peeling of santol fruit.—Continued.*

Concentration of lye	Temperature	Length of immersion	Observations
Per cent	°F	*Minutes*	
7.0	200	1	Only a thin part of surface removed, discoloration of peeled surface.
		2	Same as in 1 minute.
		3	Peeled with sufficient rubbing, no discoloration.
		4	Same as in 3 minutes, but less pressure in rubbing.
		5	Peeled off as in 4 minutes, fruits were soft.
		6	Same as in 4 minutes, fruits were soft.
8.0	140	1	Only a thin surface of the peel was removed, discolored.
		2	Same as in 1 minute.
		3	Peeled off with hard rubbing, slight discoloration.
		4	Peeled off with less rubbing, no discoloration.
		5	Peeled off as in 4 minutes, but fruit is soft.
		6	Same as in 5 minutes.
8.0	200	1	Only a thin part of the peel, clean fruit discolored.
		2	Almost like in 1 minute.
		3	Peeled off but fruit is discolored.
		4	Peeled off easily, no discoloration.
		5	Peeled off as in 4 minutes, but fruits soft.

The procedure finally adopted in this work consisted of dipping the fruit in a kettle of hot water for at least two minutes and then dipping the washed and surface-warmed fruit in a 5 per cent lye solution at 200°F for 3 to 5 minutes. After the lye treatment the fruit was subjected to cool-water washing to remove the outer skin loosened by the alkali from the flesh. The process adopted is shown in the flow sheet.

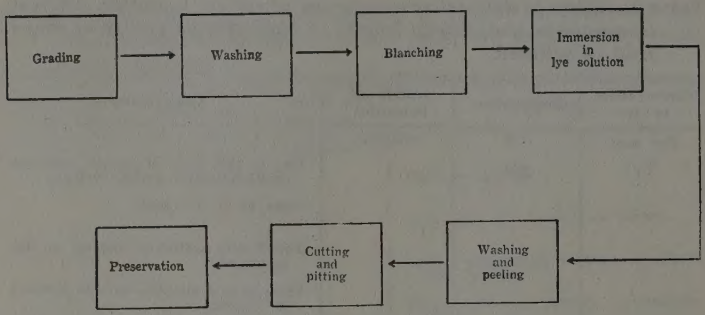

FIG. 1. Flow sheet on the chemical peeling of santol fruit.

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PHYSICAL AND CHEMICAL PROPERTIES OF ANUBING (ARTOCARPUS CUMINGIANA TREC.) LATEX*

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ONE TEXT FIGURE

Artocarpus cumingiana Trec. is locally known as *anubing* in Tagalog, especially in Laguna and neighboring provinces. This tree has attracted our attention because it is a species found only in the Philippines. It commonly grows in forests at low and medium altitudes from northern Luzon to Palawan and Mindoro.

We have examined the *anubing* latex (coagulated mass and milky juice). The constants and the solubility of the latex and the resins isolated from it were both determined.

Qualitative tests have shown the presence of proteins and waxes but carbohydrates and tannins were absent.

Concerning the *Artocarpus* Forst., A. D. Elmer states:

> Species 40, widely distributed throughout tropical Asia and in the Pacific islands. In the Philippines we recognize 16 species, 3 of which yield edible fruits and the wood of most of our species is hard and heavy, yellowish, either with a distinct bitterish or sweetish taste, and is much employed for structural purposes. The gum is used in caulking small boats and the coagulated milky sap is occasionally gathered by the natives for a substitute for chewing gum. The younger folks also use it in making simple bird traps. The nuts of a few species are said to be roasted and used as food. The bark of young trees of some of our species is used by mountain tribes as "gee-strings."

EXPERIMENTAL PROCEDURE

The latex sample used in this investigation was obtained through the kindness of Mr. Filemon A. Cabungcal of Lucban, Quezon Province. This was a day's collection from the tappings of a single *anubing* tree growing in the forest of Lucban, Quezon.

Precautions observed in the preparation of the sample.—As soon as incisions were made on the bark of *anubing* tree the

* This project is the second in a series of investigational work on Philippine natural gums and resins now being undertaken for the purpose of compiling basic fundamental data.

exudate in the form of a thick white fluid was collected in a well-stoppered container and kept in a refrigerator. On standing, however, even in a refrigerator, the liquid portion at first developed a brownish color which gradually turned black while the coagulated mass remained unaffected. In order to avoid further discoloration the latex had to be washed right away as follows:

Preliminary treatment of the latex.—The latex was cleaned and freed of its impurities by the method devised by Tanchico and Magpantay[1] in their investigation of **nanka** latex by successive heating with water (below boiling) and cooling as many times as required.

Solubility.—A small amount of the washed latex was treated with one cubic centimeter of the solvent and the mixture observed after vigorous shaking. If the latex was not soluble it was heated on a water bath and again observed.

In the cold the latex was:

1. Soluble in chloroform, petroleum ether and benzene.
2. Largely soluble in carbon tetrachloride, carbon disulfide, benzene, ether and acetone.
3. Partly soluble in ethyl alcohol and absolute alcohol.

Before proceeding to the analysis the latex was allowed to stand for two or three days to acquire a moisture content at room temperature. The combined weights of the acetone-soluble and the insoluble matter subtracted from the original weight of the sample gave the moisture content of the latex.

Analysis of the latex.—An outline of the method we used for analyzing *anubing* latex is given in Fig. 1. According to this procedure the different constituents were isolated by solvent extraction.

In Table 1 is given the composition of duplicate samples of *anubing* latex we have analyzed. The amounts of the different constituents are given below:

Latex constituents.—Table 1 shows that the acetone-soluble constituent consists mainly of resins whose wax content is about

[1] Philip. Jour. Sci. **87** (1958) 149-157.

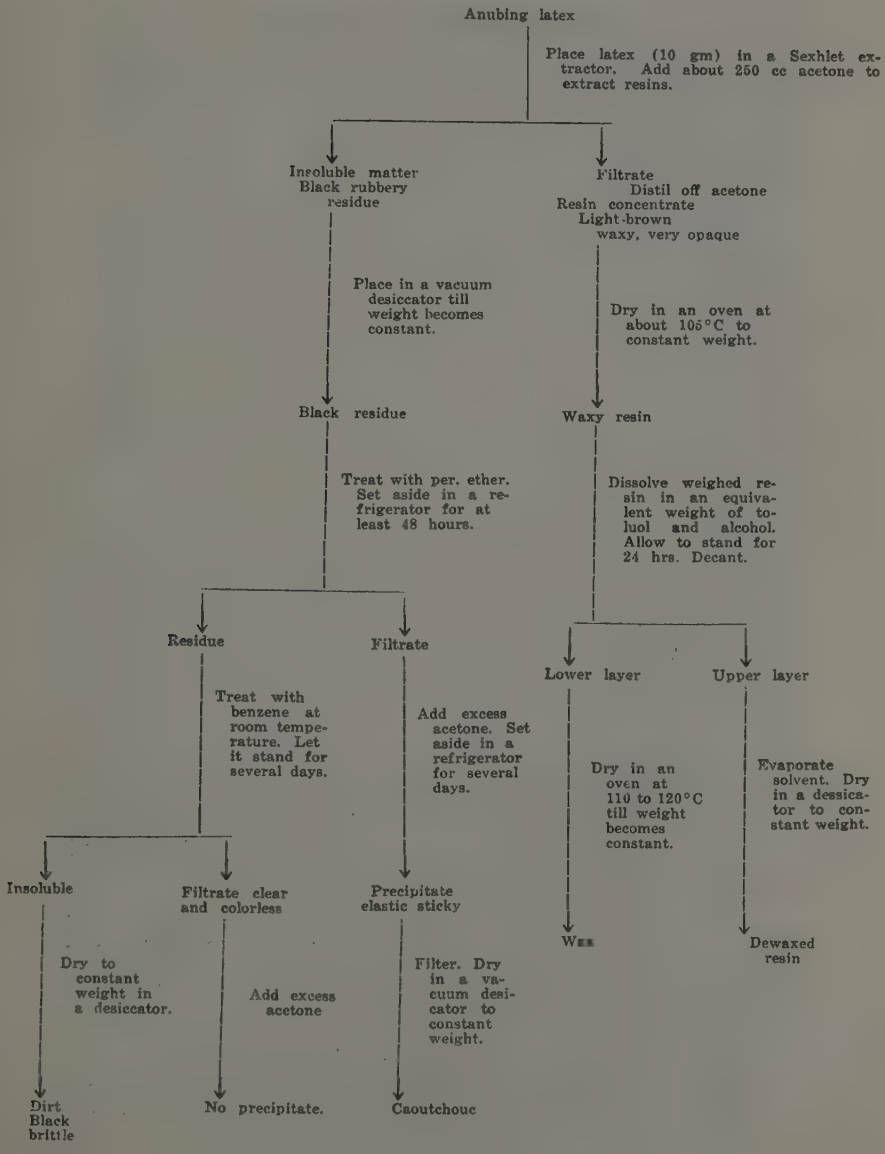

FIG. 1. Method employed for analyzing *anubing* latex.

TABLE 1.—*Composition of anubing latex.*

Constituent	Sample I	Sample II	Average
	Per cent	*Per cent*	*Per cent*
Resin (acetone soluble)	71.39	71.84	71.61
"Wax" in resin	45.68	45.76	45.72
Dewaxed resin	25.71	26.08	25.89
Albanes	13.13	13.32	13.22
Fluavilles	12.58	12.76	12.67
Insoluble matter	8.31	8.02	8.17
Caoutchoue	6.61	6.63	6.62
Dirt	1.70	1.39	1.55
Organic	1.47	1.20	1.34
Inorganic	0.23	0.19	0.21
Moisture (by diff.)	20.30——	20.14——	20.22——
TOTAL	100.00	100.00	100.00

twice as much as the resin itself. The resin in turn contains not only white resins (albanes) but yellow resins (fluavilles) also. The most striking and perhaps surprising feature of the results is the fact that a considerable amount of waxes was found to be present in the acetone extract which usually consists of resins alone. This is not unusual, however, because A. H. Wart[2] cites occurrence of waxes in latex trees.

The black rubbery residue left behind after the acetone extraction consists of benzene-soluble caoutchouc and benzene-insoluble dirt (organic and inorganic).

These duplicate samples taken from the same tree have about the same composition.

Acetone-soluble matter (resins).—The different constituents of the latex especially the resins were isolated following the procedure adopted by Tanchico and Magpantay[3] which utilized boiling acetone as the solvent.

Observations on the acetone extract:

When the acetone extract was allowed to cool before distilling off most of the acetone it was noticed that a large portion of

[2] Chem. Tech. Waxes (1947) 150-152.
[3] Op. cit.

the resins has separated and settled in the form of white brown-tinted waxlike incrustations at the bottom of the flask with a light-yellow filtrate on op. This has seemed to indicate that there were, perhaps, at least three different constituents in this extract; namely, yellow resin (yellow filtrate), white resin (white incrustations), and probably a wax (brown tint).

After distilling off most of the acetone in the acetone extract the concentrate was poured into a tared beaker and concentrated further by evaporating on a steam bath. When the acetone concentrate was placed in an oven at 105°C and dried to constant weight a very light-brown waxy resin was obtained.

Scott's[4] *qualitative test for waxes.*—When a portion of the extract was warmed with absolute alcohol and then allowed to cool waxes deposited at the bottom of the flask.

Determination of per cent "wax."—A modification of Mantell's[5] procedure was adopted as follows: One gram of waxy resin was dissolved in one gram of toluol. One gram of ethyl alcohol was then added with stirring and the mixture covered and allowed to stand 24 to 48 hours. The liquid was decanted off into a weighed beaker. When separation was completed the lower layer consisting of the "wax" was dried overnight at 110° to 120°C while the upper layer (dewaxed resin) was concentrated and dried to constant weight in a desiccator.

Note: If after one extraction the "wax" was not pure as shown by the presence of white particles on the wax layer (lower layer) the whole procedure was repeated until a pure "wax" was obtained.

Should the alcohol be less than what was required no layers would be visible at all but if the alcohol was more than what was required not only the wax but the presence of white particles, possibly albanes, which are insoluble in excess of cold alcohol, could easily be detected in the lower layer.

Separation of the resins.[6]—The "dewaxed" resin obtained from the determination of the "wax" was dissolved in hot ethyl alcohol giving a light yellow solution. After standing for about four hours the white precipitate formed was filtered through a weighed filter paper and washed repeatedly with cold ethyl

[4] Std. Meth. Chem. Anal. 5th **2** (1946) 1949.
[5] Tech. Nat. Res. (1942) 465.
[6] Anon., India Rubber Jour. **64** (1922) 179.

alcohol until the washings were no longer colored. This precipitate consisting of white resins (dammar) was dried to constant weight in a vacuum desiccator. The yellow filtrate (combined washings) was evaporated on a steam bath and dried to constant weight in a vacuum oven at 105°C. These were the yellow resins (dammar). If after repeated filtrations the filtrate was not clear it should be allowed to stand overnight before filtering. This precaution was taken so that no white resin could pass to the filtrate thus insuring a complete separation of the white and yellow resins.

Thus our suspicion that the benzene extract consists of water-insoluble white and yellow resins based on our previous observations was confirmed.

Petroleum extract.—The residue which was dried to constant weight in a desiccator was then immersed in petroleum ether and kept in a refrigerator with periodic changing of petroleum ether and occasionally shaking the mixture. When extraction was complete, excess acetone was added to the filtrates and washings and again placed in a refrigerator for several days. The precipitate of [illegible], which was plastic and sticky, was filtered through a tared filter paper, washed several times with acetone and dried to constant weight in a desiccator. On standing, however, the precipitate became hard and brittle.

The material which did not dissolve in petroleum ether was treated with thiophene-free benzene and allowed to stand for several days at room temperature with constant agitation. Excess acetone was added to the benzene solution. No precipitate was formed indicating the absence of gutta.

Dirt.—The residue left on the filter paper after extracting with hot petroleum ether and thiophene-free benzene was dried to constant weight in a vacuum desiccator. The black brittle residue consisted of [illegible] dirt, organic and inorganic. This was further incinerated to dull redness until it was almost white ash, allowed to cool and weighed to constant weight. The ash gave the weight of the inorganic dirt, while the loss in weight before and after incineration gave the organic dirt.

[a] [illegible]
[b] Scott, W., Stand. Methods Chem. Anal. [illegible]

Moisture.—Moisture was readily calculated by difference, that is, the difference between the weights of the original sample and the sum of the weights of resin and acetone-insoluble matter.

Solubility of the resin.—To a small piece of resin obtained by drying the acetone extract was added one cubic centimeter of the solvent. The mixture was agitated vigorously and if the resin was not soluble in the cold it was heated on a steam bath.

In the cold the resin was:

Soluble in toluene, kerosene, chloroform, carbon tetrachloride, carbon disulfide and benzene. Largely soluble in petroleum ether, ether and acetone. Partly soluble in ethyl alcohol and absolute alcohol.

By heating the solutions of petroleum ether, ether and acetone the resin was rendered more soluble. However, in the case of ethyl alcohol and absolute alcohol, they did not dissolve the resin completely although it was rendered more soluble.

The different resin constants were determined according to the following procedures:

Acid number.—The acid number was ascertained by treating approximately one gram of the resin with 50 cc of a neutral mixture of equal volumes of benzene and absolute alcohol. The solution was titrated with 0.5N KOH in the presence of phenolphthalein.

Saponification number.—Since this resin is not completely soluble in absolute alcohol Mantell's[9] procedure was adopted by dissolving one gram of resin in a mixture of 25 cc toluol and 25 cc ethyl alcohol. Ten cubic centimeters of 0.5N alcoholic KOH carefully run down from a burette was added. The mixture was heated with a reflux condenser for about 45 minutes and then titrated with standard 0.3N aqueous solution of sulfuric acid with phenolphthalein as indicator. A blank determination was run with this sample.

Ester number.—Ester number is the difference between the saponification and acid numbers.

Melting point.—The melting point was determined by the mercury method of Durran as modified by Rangaswami.[10]

[9] Tech. Nat. Resins (1942) 466.
[10] Handb. Shellac Anal. (1942) 91.

Data on these constants are given below:

Sap. No.	75.19
Acid No.	0.75
Ester No.	74.44
M. P.	63.00

SUMMARY

Artocarpus cumingiana Trec., locally known as *anubing*, has attracted our attention because it is a species found only in the Philippines. The gum is used for caulking small boats and occasionally gathered by the natives as a substitute for chewing gum.

The most striking feature of the results is the fact that a considerable amount of waxes was found to be present in the acetone extract which was supposed to consist mostly of resins alone. The wax content is about twice as much as the resin itself which contains both white resins (albanes) and yellow resins (fluavilles).

Thus our hint that the acetone extract contains waxes besides the white and yellow resins based on our previous observations was confirmed.

The black rubbery residue left behind after the acetone extraction consists of benzene-soluble caoutchouc and benzene-insoluble dirt (organic and inorganic).

A PROCESS FOR THE PREPARATION OF QUALITY WATER-WHITE COCONUT OIL

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ONE TEXT FIGURE

Long before the expeller was brought to the Orient from the West, Oriental people had been making their oil for home use either by simply boiling the expressed liquid from freshly grated coconut meat or by boiling the pounded dried meat and skimming off the liberated oil, as practised in Cochin, India, to produce quality coconut oil.

For a long time Filipinos have been making their coconut oil by boiling the coconut milk, called "gata" by the Tagalogs, Bicolanos and Visayans; and "getta" by the Ilocanos. Because water is added to extract the milk from the grated coconut meat, the process of obtaining the oil takes a long time as considerable amount of water has to be evaporated. The resultant oil obtained from this method has a brown color and oftentimes has also a burnt odor and taste.

There are various methods of extracting coconut oil from ripe coconuts. Gonzaga's[1] process consists of grating the meat in a machine similar to the corn mill or the hammer mill. Sufficient water is added to cover the material and then the mixture is pressed in a specially designed roller machine. The expressed liquid is allowed to stand in a tall container, after which only the upper creamy layer is taken out and subjected to a carefully controlled heat until the flocculent solids have sufficiently coagulated and can easily be filtered out. Overheating the material is avoided; otherwise, the resulting oil will have a disagreeable odor and a burnt color. The oil thus obtained is colorless having a pleasant sweetish odor and is suitable for culinary purposes without further purification. For storage purposes, however, it is necessary to dehydrate or remove the remaining traces of moisture in the oil by heating it or by using

[1] Process of Recovery of Oil from Ripe Coconuts, P.I. Patent No. 3, December 8, 1948.

an oil purifier. The equipment required by the Gonzaga process is so expensive that only few people in the rural areas can afford to install it. Moreover, it is operated by electric power, which is not available in most of the rural places.

Lava's process is as follows:[2] The comminuted coconut meat is mixed with water five times its own weight and the temperature of the mixture is kept between 22° to 60°C. This heated mixture is passed through a roller mill whereby an oil-in-water emulsion is formed. The resulting extract is subjected to high-power centrifugal action, until a viscous emulsion, an aqueous extract, and a residue are obtained. The "sapal," with the proper amount of water added, is passed through the roller a second or third time. The viscous emulsion and residue are thoroughly mixed, and the mixture subjected to heat at a temperature up to 280°C to obtain the oil. Lava did not describe the oil he obtained by this process, but it is surmised that this oil is colored and has a burnt odor and taste brought about by the high temperature used in the operation. Like Gonzaga's process, this too cannot be adopted by rural folk as it entails the use of expensive equipment run by electric power.

Alexander Wallace[3] of the United States prepared oil from the creamy portion of the milk expressed from comminuted meat. He added 10 to 20 per cent water to the cream and autoclaved the mixture for two hours while a steam pressure of 10 to 20 lbs. developed. As soon as this pressure was released, the autoclaved liquid was centrifuged to obtain dry oil. But, like Gonzaga's and Lava's processes, the cost of equipment employed is beyond the reach of many people in the Philippines.

Parker and Brill[4] steamed comminuted coconut meat which had been soaked in water for three hours and pressed it afterwards to obtain a white emulsion consisting of cellular tissue, oil, and water. Boiling a portion of this white emulsion, they obtained brown oil with burnt odor and taste. They stated that removal of water from the emulsion with reduced pressure would not improve the oil as the jelly mass of oil and cellular

[2] Process of Recovery of Oils from Vegetable Materials, U.S. Patent No. 2,101,371, December 7, 1937.

[3] Process for Preparation of Food Products from Fresh Coconuts. U. S. Patent No. 1,366,339, January 25, 1921.

[4] Philip. Jour. Sci. 12A (1917) 87-94.

tissue had to be heated at higher temperatures to completely free the oil. The oil had burnt odor and taste. This method cannot be adopted for the same reason that the equipment is costly and, besides, the preparation of the milk is rather laborious.

Since none of the methods described above is sufficiently cheap and practical for adoption, a study has been made for an easier yet inexpensive way of producing quality coconut oil. The procedure below, which is the result of our study, describes a new method which may be used by rural housewives as well as by those in cities in obtaining quality water-white coconut oil cheaply and satisfactorily.

PROCEDURE

Ten mature and fresh nuts are cut into halves. The coconut water is saved to be used in a later step of the process. Only good nuts are chosen, as spoiled nuts have an off odor quite distinct either with the water or with the meat. As the motor-driven burring machine is not available in our laboratory, the simple home grater, "kudkuran," which is available in many rural homes, is used. The halved nut is held by both hands and pressed up and down against the circularly arranged teeth of the grater. The coarseness of the particles depends on the pressure applied by the hand while grating. Gentle pressing gives finer particles while hard pressing gives coarser particles.

The grated meat is wrapped by the handful in a cheesecloth. It is then hand-pressed without additional water. Even after an hour's gravity separation, this first milk extract does not separate an aqueous layer which we may properly call coconut skimmed milk. This first extract appears as a rather thick emulsion. Invariably it contains 44 per cent oil and about 50 per cent, more or less, water. The coconut water is added to the residue of the first pressing and is worked with the hands for a few minutes after which it is pressed again in a cheesecloth. The second extract, which is rather thin, is filtered and allowed to stand in a container to separate the skimmed milk by gravity separation.

In an hour, the cream forms as the top layer. The creamy layer appears denser than the skimmed-milk layer below it. The lower watery portion is removed by siphoning into a separate container or by just opening the stopcock, if a separatory

funnel is used, and is set aside. The first and second cream extractions are mixed in a cooking vessel, preferably an enameled pot, and boiled to produce quality water-white oil. The boiling is brisk until a jellylike mass is produced, after which the heat is reduced just enough to simmer it. Stirring is continuous.

As the water evaporates, the jellylike proteinous mass separates from the oil; loses its stickiness; and does not adhere to the sides or bottom of the container. The mass then breaks up into small rounded bodies; as these shrink in size, their color changes from whitish to tan, then to light brown. When the light-brown color is obtained, the oil is filtered with cloth. The brownish protein bodies can be heated for a longer period to obtain a small amount of brown oil. The brown oil thus obtained may have a burnt smell depending on the degree or extent of heating the protein. The filtered oil, on the other hand, is water-white, but as it cools off may display light opaqueness. When this happens, the oil is heated to evaporate the water thoroughly. Dry oil is perfectly clear and does not show opaqueness.

It is not difficult to get water-white quality oil when the technique of producing it is learned. The burnt odor and taste of coconut oil develops when the protein and carbohydrates originally present in the emulsion are overcooked. The brown color of coconut oil is perhaps also a consequence of overcooking either the proteins or the carbohydrates or of both. Washing the cream emulsion before boiling removes the greater portion of the protein. The protein content of the cream runs up to over 2 per cent. The little protein residue left in the cream when further heated gives a slightly yellow color and imparts a mild pork odor to the oil.

DISCUSSION OF RESULTS

Examination of Table 1 shows that the figures for the physical and the chemical properties of the rural oil fall within the range obtained for coconut oils in general. These indicate that the method used in the preparation has not altered very much its properties. The difference in figures for the physical properties of the various oils may be attributed to the nature of the processes employed.

TABLE 1.—*Physical and chemical properties of various coconut oils produced by different methods.*

	Rural coconut oil[1]	Coconut oils in general[2]	Lava's oil[3]
Saponification value	253.37	251.0—263.0	255.8
Iodine number	7.8	8.0— 9.6	8.3
Free fatty acid number (per cent oleic)	0.034*	2.5— 10.0	2.37
Hehner number	81.26	82.3— 90.0	87.1
Reichert-Meissl number	7.34	6.8***	7.18***
Polenski number	20.95	15.0— 18.0***	15.39***
Melting point	27.4**	24.5— 26.0**	26.0**
Color value:			
Red	0.5	——	0.1
Yellow	2.00	——	1.0
Specific gravity (30°C)	0.9205	0.9187	0.9167
Index of refraction:			
30°C	1.4533	——	1.4490
40°C	1.4508	1.4477—1.4495	1.4455
50°C	1.4481	1.4410	1.4418
Solidifying point	15.2**		

* Per cent; ** degree centrigrade; *** cubic centimeters.
[1] Actual laboratory data.
[2] D. M. Birosel, et. al., U.P. Nat. Appl. Sci. Bull. (1939) 39-49.
[3] *Ibid.*

TABLE 2.—*Saponification value, free fatty acid number and iodine value of different oils available as compared to rural coconut oil.*

	Saponification value	Iodine value	Free fatty acid
			Per cent
1. Rural coconut oil	253.37	7.5	0.034
2. Copra oil	249.85	9.10	0.297
3. Paring oil	236.16	22.00	0.10
4. Lava's oil	255.8	7.5	2.37
5. Cold pressed dessicated meat oil	250.72	6.0	0.04
6. Warm pressed dessicated meat (Hiller's oil)	249.50	6.72	0.08
7. Cold pressed dessicated meat W & C oil*	261.40	5.40	0.05
8. Psyhico-mechanical oil	254.42	7.80	0.01

TABLE 3.—*Free fatty acid of rural oil and other oils available after a lapse of several months.*

Oils	After 4 months F.F.A.	After 10 months
	Per cent	*Per cent*
1. Rural oil	0.041	0.042
2. Copra oil	0.295	0.0417
3. Paring oil	0.135	

TABLE 4.—*Yields of products obtained from ten coconuts.*

Products	Gram yield	Percentage yield
A.		
1. Weight of 10 whole nuts (without husk)	8,422.3	100.0
2. Weight of coconut meat	3,518.3	43.44
3. Weight of shell	2,010.3	23.75
4. Weight of paring	247.6	2.92
5. Weight of coconut water	2.482.4	29.33
B.		
1. Weight of pure cream	1,976.1	56.10
2. Weight of second cream	358.7	9.19
3. Weight of sapal (dry basis; moisture 66.3 per cent)	1,184.4	33.66
4. Weight of skim milk	2,371.1	99.99
5. Weight of sapal (wet basis)	1,786.5	51.06
C.		
1. Weight of oil	777.8	33.31
2. Weight of protein in cream (without sugar)	145.3	6.22

For purposes of comparison, we have presented in Table 2 the saponification value, free fatty acid number, and iodine value of coconut oils prepared by other methods. Lava's oil is produced by centrifuging coconut cream which is pH-controlled between 3 and 5.6 by the addition of hydrochloric acid. Cold-pressed desiccated meat oil was prepared in this laboratory without the application of heat. Hiller's oil was produced by pressing warm, dry, sliced coconut meat.

The methods employed and the degree of temperature applied to the grated coconut meat to obtain the oil are factors causing the marked difference in the saponification and iodine values of the different oils. The best index for the quality of the oil is its free fatty acid content. Samples of rural, quality, water-white, copra oil and paring oil were placed under observation for several months for whatever changes that may be observed regarding their stability and shelf life.

There was no detectable change in the color, odor and flavor in the case of the rural oil. The free fatty acid of the oil at the start was 0.041 oleic acid. After the lapse of several months the change was very slight, as seen in Table 3. This shows that the oil was completely anhydrous. Hydrolysis can only take place in coconut oil when water is present in it.

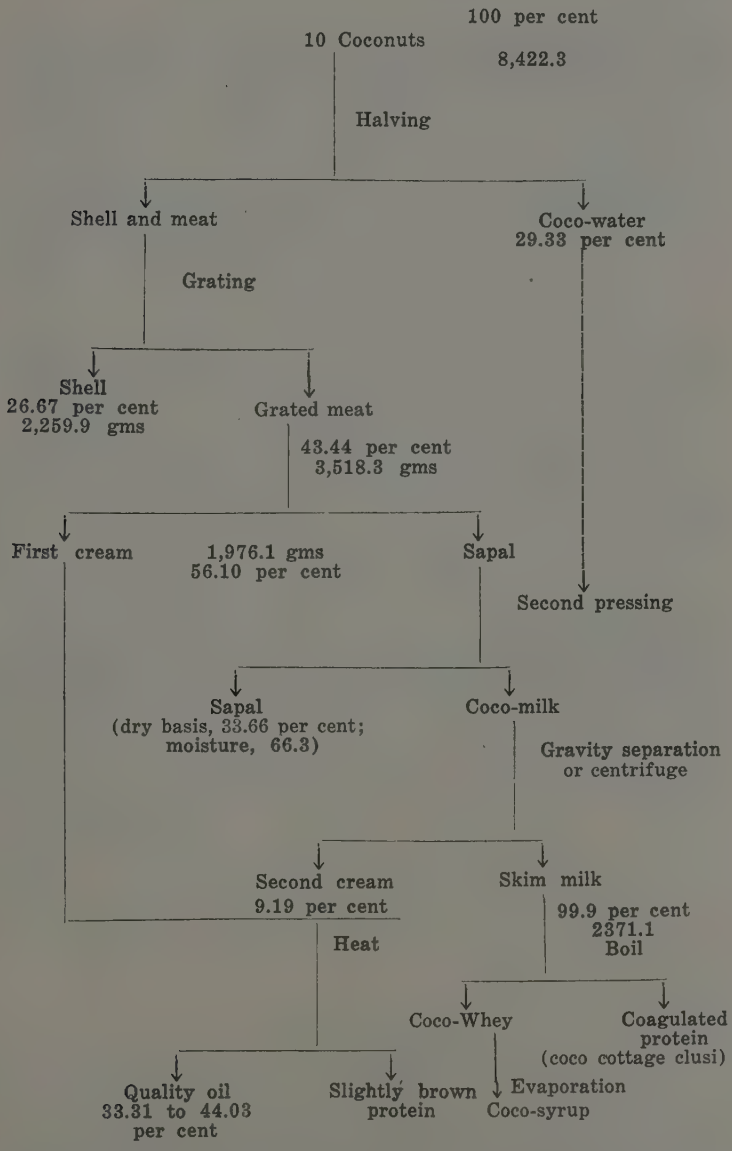

FIG. 1. *Flow sheet for the preparation of quality water-white oil and coco cottage cheese for rural use.*

At the start of the experiment the rural oil sample was clear and no sign of suspended particles was noted. After several months, however, a thin layer of brownish, fine, solid particles was present at the bottom of the container. These particles were removed by filtering twice and the oil remained perfectly clear thereafter. This showed that the oil was quite stable.

Part of the data obtained in this experiment is shown in Table 4. The flow sheet of the method adopted is also included.

SUMMARY

1. A new method of preparing water-white coconut oil without the use of complicated and expensive equipment is described.

2. The oil obtained has a remarkable keeping quality.

3. If the oil is kept to stand for quite a long time, brownish particles may form at the bottom, but these do not affect the oil when filtered.

ACKNOWLEDGMENT

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A SHORT LIST OF MANSAKA FLORA AND THEIR USES

By N. Abrams

The species noted below were identified in the mountain country east of Magnaga, Pantukan, Davao, and in the swamps near Magnaga beach. Ranger Filemon Madrid, aided by Lorenzo S. Detalla and Celestino A. Dedace identified the items of flora named by the Mansaka guide, Paspas Mansaka.

Information given includes for each species the Mansaka name, the common or official name, the scientific name, and its uses by the Mansaka people. If no use is listed for a species it is often because none other than that of firewood was given by the informants. After the Mansaka name, symbols in parentheses designate the following: B, bamboo; F, fern; G, grass; H, herb; P, palm; R, rattan; S, shrub; T, tree; V, vine. A question mark is appended when an entry is doubtful. A scientific name in parentheses or one followed by *sp.* indicates that complete identification is lacking for an item. Abbreviations in parentheses are families.

The efficacy of the medicinal uses has not yet been substantiated by personal use or the observation of Mansaka use of the medicinal flora. It is hoped that gaps in the present material will be filled in with more field work. Seven common and cultivated edible plants are not included in this list, which, for the most part, include flora observed on the trek. Uses noted are not exhaustive.

Mansaka name	Common name	Scientific name	Mansaka use
abaka[1] (S)	abacá	*Musa textilis* (Nee)	Processed for fiber
akasiya (T)	acacia (or rain tree)	*Samanea saman* (Leg.)	For building
agaen (T)	tangisang-bayauak	*Ficus variegata* (Morac.)	Container made of bark processing place of flour of bai tree (q.v.)
aggimbabarud (T)	bulala	*Nephelium mutabile* (Sapind.)	For building
agimit (T)	hagímit	*Ficus minahassæ*	Sap is source of water; ashes of bark mixed with abaca for black coloring
alabiyud (T)	libás	*Spondias pinnata* (Anac.)	
amlung (V)	amlong		Used to blacken teeth, lips
amurawen (T)	moláve	*Vitex* sp. (Verb.)	For building
anagdung (T)	anabióng	*Trema orientalis* (Ulm.)	Bark is fuel to burn sea shells for lime; bark crushed, boiled to treat fish netting.
andaramay (S)	dalunot		Bark boiled, solution put on infection
anilaw (T)	anilau	*Columbia serratifolia* (Tiliac.)	Used in building.
annayep (S)	atimla (?)		Made into knife handles
antuturub (T)	langil	*Albizzia lebbeck* (Leg.)	
anunang	anonang	*Cordia* sp. (Borag.)	Fruit made into paste; lumber for building
anuring (T) (or tumbak)	anuling	*Pisonia umbellifera* (Nyctag.)	Boiled bark tea given to newborn before 1 week old

arami (S)	ramie	*Boehmeria nivea* (Urt.)	
arem	alim	*Melanolepsis multiglandulosa* (Euph.)	For building, roofing
aribetbet (T)	matang-ulan		Tea of boiled root drunk for stomach ache
aribungug (T)		(Anon.)	
atipuru (T)	antipolo	*Artocarpus blancoi* (Morac.)	
bakal (T)	anubing	*Artocarpus cumingiana* (Morac.)	
bakan (T)	bakan	*Litsea philippinensis* (Laur.)	Made into boats
bakaw (T)	bakauan		
bagabaga (T)	gatasan	*Garcinia venulosa* (Gutt.)	
bagakay	marsh grass (?)	*Acrostichum aureum*	
baganga (T)	balákat	*Zizyphus talanai* (Rhamn.)	Fruit roasted, crushed, sap dripped into ear for earache
balaw (T)	balaw		Made into charcoal; lumber
bamban (H)	bambán	*Donax cannaeformis* (Marant.)	
banakabak (T)	bangkal (?)	*Nauclea* (genus) (Rub.)	For building
banati (T)	banati (?)		For building
banayaw (T)	ilang-ilang	*Cananga odorata* (Anon.)	For perfume; bark for walling and shingles
banga (P)	palindán	*Orania palindan* (Palm.)	Avoided (poisonous)
bangaraw (T)	pagatpát	*Sonneratia alba* (Sonn.)	For building
bansilan (T)	kalamansánai	*Neonauclea calycina* (Rub.)	For building
baraisan (P)		*Arenga* (Palm.)	Leaves used decoratively
barait (T)		*Aglaia* sp.	Combs made from root
baranawen (T)	balanigan		For building

[1] Tangungun, lakwid and magindanaw were given as separate species of abaka.

NONEDIBLE FLORA — Continued

Mansaka name	Common name	Scientific name	Mansaka use
baranti (T)	hamindang	*Macaranga bicolor* (Euph.)	
baratinaw (T)	talang-gúbat	*Diospyros copelandii* (Eben.)	
baraw (T)	apitong (?)	*Dipterocarpus* sp. (Dipt.)	For building
barukawit (B)	bikal	*Schizostachyum diffusum* (Gram.)	Made into flutes
barungkanas (T)	buho	*Schizostachyum lumpao* (Gram.)	
barungilit	diliuáriu	*Acanthus ilicifolius* (Acanth.)	
bawing (H)	saluyot	*Malvastrum coromandelinum* (Malv.)	Used for perfume
bayang (T)	hinlaumo	*Mallotus ricinoides* (Euph.)	Fruit used as bait in bird snare
bayug (T)	bayók	*Pterospermum diversifolium* (Sterc.)	
bedbed (T)	balete	*Ficus balete* (Morac.)	Used in religious life
berekberek (T)	baní	*Pongamia pinnata* (Leg.)	
bigi (T)	tabigi	*Xylocarpus granatum* (Meliac.)	For building
binwang (T)	binúang	*Octomeles sumatrana* (Datisc.)	Bark is scattered among rice about to seed (religious)
biyaaw (T)	lumbáng	*Aleurites molucanna* (Euph.)	
buklad (P)	yellow lanutan anáhau	*Polyalthia fava* (Anon.) *Livistona rotundifolia* (Palm.)	For building For building (roofing)
bumbilya (S)?	bougainvilla	*Bougainvillaea*	Ornamental

bungluy (T)	banai-bánai	*Radermachera* sp. (Bign.)	
burakan (V)	bulakán	*Merremia peltata* (Convolv.)	
kaburing (T)	kabúyau	*Citrus hystrix* (Rutac.)	Crushed fruit used to wash hair
kamdingkamding (H)	baho-baho	*Bauhinia tomentosa* (Leg.)	Used for matting
kapuk (T)	kapok, American	*Ceiba pentandra* (Bomo.)	Fruit used for pillows
karangkangen (S)	malasambóng	*Veronnia vidalii* (Comp.)	Made into charcoal
karibangbang (V)	agpói	*Bauhinia cumingiana* (Leg.)	Solution of boiled root drunk for cough
kasway (T)	langarai	*Bruguiera parviflora* (Rhiz.)	For building
katuwan (P)	limuran	*Calamus ornatus* (Palm.)	Rattan used for tying, basket-work
kawayan (B)	kauayan-tinik	*Bambusa spinosa* (Gram.)	Used for water-containers, and for building
kawayan na bilawan (B)	yellow bamboo (?)		Used in religious ceremony
kepet (V)	silungpugo		
kusambi (V)		*Trivervis* sp.	Heated leaf put on forehead for headache; crushed leaves in coconut oil wrapped on abdomen
dagaaw (T)	balitbitan	*Cynometra ramiflora* (Leg.)	
dangkasu (T)	kanapai	*Ficus nervosa* (Morac.)	
dáraal[1] (T)	lumbayau	*Tarrietia javanica* (Sterc.)	Made into boats
daragangan (T)	paitan	*Syzygium constulatum* (Myrt.)	
darupang (H)	kulot-kulótan	*Triumfetta bartramia* (Tiliac.)	Crushed flower put on boil
debdeb nang kasili (T)	iloilo	*Aglaia iloilo* (Meliac.)	For building

[1] á is for short vowel.

NONEDIBLE FLORA — Continued

Mansaka name	Common name	Scientific name	Mansaka use
diladila (H)		*Elephantipusmolcs* (?)	Leaves put on wound—astringent
dita (T)	ditá	*Alstonia scholaris* (Apocyn.)	
diyat (G)	daat	*Cyperus* sp.	Tea of new buds relieves pain
dugwan (T)	duguan	*Myristica philippensis* (Myrist.) (Sterc.)	
dungun (T)	dungun		
duul	prop root (?)		
gaan (S)	salago	*Wikstroemia* (Thymel.)	Cottonlike bloom used for pillows
gapas (S)	cotton tree		Thread for weaving
gikayan (T)	salinggógon	*Cratoxylon cochinchinense* (Gutt.)	Made into pestles
gisek (T)	guijo	*Shorea guiso* (Dipt.)	Used for building
ibu (T)	malugái	*Pometia pinnata* (Sapind.)	Used for fuel
ità (T)	pútat	*Barringtonia racemosa* (Lecyth.)	
lagtang (V)	ligtáng	*Anamirta cocculus* (Menisp.)	Used to poison fish
lambayung		*Solanum* (Solan.)	
lanes (T)	jatoba		
langgit	langguas (?)	*Toona calantas* (Meliac.)	For building—flooring, walling
lanipgà (T)	kalantas		
laniti (T)	kalatingan		
lanutan (T)	Vidal's lanutan	*Bombycidendron vidalianum* (Malv.)	
lawáan na mapura (T)	red lauan	*Shorea negrosensis* (Dipt.)	For building
lawáan na maputi	white lauan	*Pentacme contorta* (Dipt.)	For building
lawingan (T)		*Tiperanium* sp.	

leket (R)	tandulang-gubat		For tying, basketwork
lenek (S)	makahia	*Mimosa pudica* (Leg.)	Leaves soaked in coconut oil put on wounds, ulcers, etc.
limbaan (T)	malaikmo	*Celtis philippensis* (Ulm.)	For building
limputut (S)	calachuche	*Plumeria acuminata* (Apocyn.)	
linas (T)	manggachapui	*Hopea acuminata* (Dipt.)	For building
lingaw (S)	lipa	*Laportea luzonensis* (Urtic.)	
lipay (V)	cyntrusima (?)		Buds chewed to blacken lips
lubù (G)	kógon	*Imperata exalta* (Gram.)	
lukub (T)	pagsahingin (?)	(Burs.)	Used for roofing
lugaung (T)	binunga	*Macaranga tanarius* (Euph.)	
makangngasa (T)	danglin	*Vitex aherniana* (Verb.)	Made into flutes, blowguns
magabaung (T)	balakat-gubat	*Sapium luzonicum* (Euph.)	Used for building
magaburay (T)		*Bruguiera* sp.	
magakasili (T)	malapapaya	*Polyscias nodosa* (Aral.)	For building
magadulyan (T)	tanghas	*Myristica simiarum* (Myrist.)	For building
magarinabut (T)	matangaraw		Leaves boiled down, and sticky residue spread on teeth
magasamuru (T)	malaságing	*Aglaia diffusa* (Meliac.)	
magasinaru (T)	manggasinoro	*Shorea philippinensis* (Dipt.)	For building
magsayap (T)	lanipau (?)	*Terminalia crassiramea* (Comb.)	For building
magtimbang (T) (?)	kakaute (madre-cacao)	*Gliricidia sepium*	
magulung (T)	magilik	*Premna cumingiana* (Verb.)	
maguribas (T)	libás	*Spondias pinnata* (Anac.)	For building
maguritem (T)	talang-gúbat	*Diospyros copelandii* (Eben.)	
malluwas (T)		(Myrt.)	For building
mamaen (P)	betel palm	*Areca catechu* (Palm.)	Nut is chewed
mangangasin (V)	asinasin		

NONEDIBLE FLORA — Continued

Mansaka name	Common name	Scientific name	Mansaka use
marabigà (root)	biga	*Alocasia macrorhiza* (Arac.)	Crushed root squeezed over wound
marabyed (T)	talúto	*Pterocymbium tinctorium* (Sterc.)	
marambagu (T)	malubágo	*Hibiscus tiliaceus* (Malv.)	Bark made into twine
marubù (V)		*Vanillya philippensis* (?)	
matamata (T)	bolon	*Alphonsea arborea* (Anon.)	For building, oars, mortars
mayangged (V)		*Entada* sp.	
nitù (V)	níto	*Lygodium circinnatum* (Schiz.)	Made into baskets
padawat (G)			Crushed leaves put on wound
pamantigi nang amu (G)	magkawayan (Cebuano) name)		
pamentangen (H)	takling-baka	*Sida rhombifolia* (Malv.)	
panyungan (T)		*Beilschmiedia* sp. (Laur.)	
parasan (R)	palasan	*Calamus maximus* (Palm.)	Rattan used in building; leaves for roofing
parina	batete	*Kingiodendron alternifolium* (Leg.)	
Pesa nang manuk (T)		*Solanum* sp.	
pilì (T)	pagsahingin	*Canarium aspersum* (Burs.)	For building
pitugu	pitógo	*Cycas circinalis* (Cycad.)	Fruits scraped, applied to ulcers
piyagaw (T)	piagau	*Xylocarpus moluccensis* (Meliac.)	
pungapung (T)	malaanónang	*Shorea polita* (Dipt.)	

sakati (G)	bermuda grass	*Cynodon dactylon* (Gram.)	Sprouts chewed, spit on wound (astringent)
sagasa (F)	lokdo	*Dryopteris pteroides* (Polyp.)	
sambanugaw (V)	kansasaga	*Abrus precatorius* (Leg.)	
sambanutan (R)	tandulang-gubat		For roofing
sanduka (T)	putían	*Alangium meyeri* (Alang.)	
sangaan (S)	lumuluas	*Zizyphus hutchinsonii* (Rhamn.)	
sarà (T)	hamindang	*Macaranga bicolor* (Euph.)	Sap of leaf is eye medicine; root applied to head for headache
sarungkigi (T)	salingkugi	*Albizzia saponaria* (Leg.)	
sasà (P)	nipa	*Nypa fruticans* (Palm.)	For building
silad (P)	burí	*Corypha elata* (Palm.)	Used for matting
sunting (S)	akapulko	*Cassia alata* (Leg.)	
tabaan (T)	ságing-ságing	*Aegiceras corniculatum* (Myrsin.)	
takipan (T)	takip-asin		
takung (S)	labáyo	*Melochia umbellata* (Sterc.)	
tagem (S)	tagum		Made into black dye
talitali (V)	kumbulbulasi (?)		
tambabasi	tubangusa		Scraped stalk used on "pink eye"
tamberang (B)	guho (?)		Made into fences, baskets
tamisan		*karandai* sp.	
tanabeg (T)	hauíli	*Ficus hauili* Blco. (Morac.)	Sap of leaf and trunk rubbed on skin growths
taramuru (T)	bolong-eta		For building
tarutu	talúto		
tilad (T)	tibig		Leaves boiled, residue spread on teeth

NONEDIBLE FLORA — Continued

Mansaka name	Common name	Scientific name	Mansaka use
tubangan (V)	gogo	*Entada phaseoloides* (Leg.)	Sap used for soap
tugaywis (S)	pandakaki	*Tabernaemontana pandacaqui* (Apocyn.)	
umbaga (T)	anagap	*Pitchecolobium scutiferum* (Ulm.)	
urayan (T)	katiban (?)		House building
uringin (T)	paguríngon	*Cratoxylon celebicum* (Gutt.)	
urisi (R)	sika	*Calamus spinifolius* (Palm.)	
urus (T)	is-ís	*Ficus ulmifolia* (Morac.)	
uwag (orchid)		*Vanda* sp.	
warasiman (H)	botobotonis	*Euphorbia pilulifera* (Euph.)	Food for pigs; fruit ground given to infants as laxative
yakal[1] (T)	yakal	*Shorea gisok* (Tacc.)	For building
yantekan	caballero	*Caesalpinia pulcherrima* (Leg.)	

EDIBLE FLORA

agingkakarang (T)	sambong	*Blumea balsamifera* (Comp.)	Leaves boiled, solution bathed in after long illness; roots boiled, solution quenches thirst
arum (H)	siitan		Used in soup
anggus (T)		*Eucalyptus* (?)	Fruit eaten
bagu (S)	bagó	*Gnetum gnemon* (Gnet.)	Fruit eaten
baì (P)	pugáhan	*Caryota cumingii* (Palm.)	Pulp eaten; felled stalk made hatching place of edible worms

[1] If it has yellow bark it is called gisek.

barabadan (or karapi)	talahib	*Saccharum spontaneum* (Gram.)	Leaves for roofing; inner pulp of trunk and fruit eaten
barubu	balobó	*Diplodiscus paniculatus* (Tiliac.)	For housing; edible fruit
baungun (T)	suha		
bayabas (T)	bayabas (or guava)	*Psidium guajava* (Myrt.)	Fruit eaten
bukado	abucado	(Genus) *Persea*	— do —
bugkà (T)	lansónes	*Lansium domesticum* (Meliac.)	— do —
kakaw (T)	cacao	*Theogroma cacao* (Sterc.)	For cocoa
kagukù (T)	paguríngon	*Cratoxylon celebicum* (Gutt.)	Sour red fruit
kalamunggay (T)	horse-radish tree	*Moringa oleifera* (Môring.)	Leaves use for seasoning
kamansi (T)	kamansi	*Artocarpus camansi* (Morac.)	Fruit eaten
katumbal (S)	sili		Pepper for seasoning
dulyan (T)	durian	*Durio Zibethinus* (Bomb.)	Fruit eaten
iba (T)	kamiás	*Averrhoa bilimbi* (Oxal.)	— do —
iyug (P)	coconut palm	*Cocos nucifera* (Palm.)	Fruit, sap eaten; leaves for roofing
labunaw (T)	bayanti	*Aglaia llanosiana* (Meliac.)	Fruit eaten
langkà (T)	nángka	*Artocarpus heterophylla* (Morac.)	— do —
lenga (H)	linga	*Sesamum orientale* (Pedal.)	Pounded, used for soup, etc.
lumbiya	lumbiá	*Metroxylon sagu* (Palm.)	Pulp is source of starch
makupa (T)	makópa	*Syzygium samarangense*	Fruit eaten
maranyug (P)	sagisi	*Heterosphathe elata* (Palm.)	Pulp eaten, used in soup; wood used in flooring
mareng (T)	marang I	*Artocarpus odoratissimu* (Morac.)	Fruit eaten

NONEDIBLE FLORA — Continued

Mansaka name	Common name	Scientific name	Mansaka use
paku	pako	*Athyrium esculentum* (Polyp.)	Edible vegetable
pangi (T)	pangi	*Pangium edule* (Flac.)	Fruit eaten
parari (T)	katmon-kalabáu	*Dillenia reifferscheidia* (Dill.)	— do —
sibukan (T)	sampálok (or tamarind)	*Tamarindus indica* (Leg.)	— do —
tagbak	tagbak	*Kolowratia elegans* (Zing.)	Red growth on roots eaten
tawal (V)	hanopól	*Conocephalus suaveolens* (Morac.)	Used for water
tegep (T)			Fruit eaten; bark chewed

THE MARINE ALGÆ OF THE HUNDRED ISLANDS, PHILIPPINES

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TWELVE PLATES

Since their proclamation as a National Park in 1931, the Hundred Islands have been a favorite vacation site and picnic ground for vacationists and excursionists. But to the scientists who visit them, the islands have more scientific and educational importance than mere sightseeing interest. Located near 16°,11′ North latitude and 120°,01′ East longitude, 3 miles off the shore of Lucap, a small fishing barrio of Alaminos town, Pangasinan Province, the islands range from less than a meter to about a mile in length. They are mostly uninhabited, except for a few where fishermen live. The shores are for the most part precipitous or overhanging. White sandy beaches can be found on the larger protected shores. Toward the mainland to the south, soil may cover the steep island slopes to the shore, and overhanging or vertical solid rock shores are less conspicuous.

The vegetation on most of the islands, which are mostly composed of rocks with only small amounts of soil, is quite sparse. Mangroves (predominantly of the genus *Rhizophora*) may be found between the islands near the mainland. Though sparsely populated in terms of vegetation above sea level, the islands have, below sea level, luxurious gardens of marine fauna and flora about which little is known, although people there have been using some of the marine plants, in particular the algæ, as food for many generations.

From a scientific point of view, little is known of the marine algæ of the Philippines as a whole. Since to obtain the beginning of botanical knowledge for any area, a floristic survey is needed first, the present study was undertaken to provide a checklist of the species of marine algæ and at the same time to initiate an ecological survey of the Hundred Islands. Specifically its object is to construct a key to the species to distinguish one from another and to furnish each with a brief

description. It is also the purpose to call attention to species which are specially abundant and which may become economically important.

REVIEW OF LITERATURE

Philippine phycological literature is scanty considering that only a few articles and papers on marine algæ have been written and published in the Philippines. Most of the studies completed concerning the local marine flora were either undertaken by foreign scientists who collected, studied and published on their own materials; or at the least worked on specimens which had been sent abroad for classification.

Of the early workers, Blanco, (6) using the Linnæan system of classification, attempted to identify some marine plants, and although some of his species were erroneously identified he should be credited for his pioneering work.

Merrill's(37) Species Blancoanæ, a critical revision of the Philippine plants described by Blanco and Llanos, dealt in part with the algæ described by Blanco. The systematic enumeration included the class Chlorophyceæ, under which families Ulvaceæ, Codiaceæ, and Characeæ were the only ones represented. *Enteromorpha intestinalis* (L.) Link and *E. prolifera* J. Agardh are the only species representing the Ulvaceæ, and only *Halimeda opuntia* (L.) Lamx., the Codiaceæ. Under the class Phæophyceæ and family Dictyotaceæ there is *Padina australis* Hauck and under the Fucaæ, *Fucus natans* Blanco, and a *Sargassum* species. Of the class Rhodophyceæ, only the genus *Gracilaria* is mentioned.

G. von Martens(36) in a more comprehensive report on the Philippine algæ recorded 75 species as occurring in the Philippines, four being fresh-water species.

Dickie(17) recorded 47 species of algæ from the Philippines in a report on the Expedition of H.M.S. "Challenger."

In 1932, M. A. Howe(29) published his work on the classification of some of the algæ collected by Lt. H. C. Kellers of the U.S. Navy Medical Corps in Panay and Negros Islands in 1929. Kellers was a surgeon on the Naval Eclipse Expeditions of 1929 and 1930. Doctor Howe, who received the collections, enumerated 21 species in the Chlorophyceæ, Phæophyceæ, and Rhodophyceæ.

Based on the collections of the Siboga Expeditions, the works of A. and E. S. Gepp,(22) Miss E. S. Barton(4) (later Mrs. E. S. Gepp), and A. Weber van Bosse,(52) are important references since they include a number of marine algæ from the Philippines.

Perhaps the most detailed and comprehensive study of Philippine Chlorophyceæ is that of William J. Gilbert.(23) In 1942, in his exhaustive dissertation, he reported 96 species in his checklist, of which 88 are restricted to tropical or subtropical areas, and the remaining 8 may also be found in temperate waters. He states that of the total species 37 per cent are of wide distribution, being found in the tropical Atlantic Ocean, Caribbean Sea, and in same instances in the Mediterranean Sea, as well as in the Indo-Pacific region. Four of the remaining species are known only from the Philippines, and the rest in the Indo-Pacific area.

Artemio V. Manza,(35) the first Filipino to make an excellent detailed report on marine algæ in his "Revision of the Genera of Articulated Corallines," described seven new genera under which 29 species are newly characterized. Articulated corallines belong to the highly complex sub-class Florideæ of the class Rhodophyceæ.

The above represent our basic knowledge of the Philippine marine plants and form an important taxonomic literature for the area.

MATERIALS AND METHODS

Source of materials.—All the specimens studied were collected from the Hundred Islands off the coast of Pangasinan Province.

Collection and preservation.—A hunting knife was used for scraping algæ that were tightly appressed on rocks, and also for trimming some of the larger brown algæ; a pair of locally made diving glasses was utilized in securing the specimens, and 5-gallon kerosene cans, several wide-mouthed bottles filled with sea water were also made available for containing the algæ collected in the field.

For temporary field preservation, the specimens were soaked immediately after gathering in commercial (45 per cent) formaldehyde as a short-term preservative for the journey from the place of collection to the laboratory, a trip which took between 48 and 72 hours.

Laboratory preservation methods.—The algæ were removed from their containers, were sorted out according to genus or, as far as possible, to species, and were placed in separate bottles in 6 per cent formalin solution.

Mounting.—The specimens were mounted, whenever possible, on regular mounting sheets, with four replicates. The material was first washed, then arranged on the papers, covered by cheesecloth and inserted between newspaper sheets. The whole packet was pressed between blotters, corrugated cardboards, and plain wooden frames end boards.

Finally all specimens were labelled and numbered according to their original field numbers.

FACTORS AFFECTING THE ALGÆ

The marine plants are characteristic of two habitats: the Littoral Zone type and the Sub-Littoral Zone type. The former is that part of the shore which is covered and uncovered by tide levels; the latter is that part wherein the plants remain at all times under water.

The marked difference in the type of plants which inhabit these two zones may be easily observed. The algæ found mostly in the littoral region must be able to stand drying and, in consequence, other factors such as temperature changes and changes in salinity and hydrogen-ion concentration may also determine the plants' existence in such a region. A change in temperature may be caused by long exposure to sunlight during the summer. Alteration of salt concentration or salinity may be brought about by evaporation, while water may cause a dilution and decrease in salinity. In places where rivers have their outlet, salinity is diminished.

The nature of the substrata can also affect the algæ. Since most of the plants are either lithophytic or epiphytic on larger plants, a rocky shore-line gives the best substrate for a rich algal vegetation. In regions where sandy or muddy substrates prevail, the vegetation is more sparse, or even absent.

Aside from these factors, it must be added that wave-action or water turbulence affects algal growth. The former blocks the laying of spores on a substrate, the latter changes the

physico-chemical properties of the surrounding sea-water by mixing the surface layer with lower layers, and may also control sudden changes in temperature.

Light affects algal zonation. As Fritsch(21) states:

> In sublittoral zones it is the quality and quantity of the light that determines zonation of seaweeds. In population the upper region of the zone, Browns (Fucales) and Greens are the most dominant algæ, but in the deeper water the Reds are more abundant. Many sublittoral seaweeds are shadeforms, and they can photosynthesize with a weak light.

ALGAL DISTRIBUTION AND ASSOCIATION

To study algal association one has to watch the vegetation regularly in order to come to any concrete conclusion; the writer has not had the opportunity to make a long-term study of this kind. However, from observation alone it would seem that a typical sample of algal association would be *Halicoryne Wrightii* and *Acetabularia major*, both of the Chlorophyceæ. These plants begin to grow together in the same rocky, sandy-muddy habitat during the early part of February and disappear completely in June. They are the dominant species to be found in the particular area of collection, though scattered in the same place may be found two species of *Halimeda*, and other filamentous green algæ, as well as ell-grass (a flowering plant).

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Keys to the species by class

I. CHLOROPHYCEÆ

1. Thallus encrusted with lime 2
1. Thallus not encrusted with lime 3
2. Plants umbrellalike 4
2. Plants not umbrellalike 5
3. Thallus filamentous 6
3. Thallus not filamentous 7
4. Plants not more than 0.5 cm high .... *Acetabularia minutissima*
4. Plants more than 0.5 cm high ..... *Acetabularia major*
5. Segments discoid, kidney-shaped and jointed 8
5. Segments not as above 9
6. Threads forming a network ..... *Boodlea composita*
6. Threads not forming a network 10
7. Plants erect and flabelliform 11
7. Plants not as above 12
8. Segments not more than 1.5 cm broad ..... *Halimeda opuntia*
8. Segments more than 1.5 cm broad 13
9. Flattened segments of the plant flabelliform ..... *Udotea orientalis*
9. Plants not flabelliform 14
10. Threads branched; either no crosswalls present, or cells several times longer than broad 15
10. Threads not branched; cells about twice as long as broad 16
11. Flabellate structure up to 6.5 cm broad; holdfast not more than 5 cm long 17
11. Flabellate structure more than 6.5 cm broad; holdfast more than 5 cm long ..... *Avrainvillea obscura*
12. Plant reticulate (a netword of flat strands) .. *Ulva reticulata*
12. Plant not reticulate 18
13. Plant glossy on drying and slightly calcified 19
13. Plant chalky on drying and heavily calcified ..... *Halimeda tuna*
14. Whole plant cylindrical; with epidermis .... *Bornetella nitida*
14. Whole plant cylindrical; without epidermis 20
15. Threads erect up to 7 cm high ..... *Chlorodesmis comosa*
15. Threads entangled in a mass ..... *Cladophora fuliginosa*
16. Threads unattached, floating in a rolled mass. *Chaetomorpha brachygona*
16. Threads attached and erect ..... *Chaetomorpha antennina*
17. Plants solitary ..... *Avrainvillea erecta*
17. Plants not solitary ..... *Avrainvillea sordida*
18. Plant swollen or bladderlike 21
18. Plant not as above 22
19. Segments mostly reniform ..... *Halimeda cuneata*
19. Segments not reniform ..... *Halimeda discoidea*
20. Plants more than 4 cm high ..... *Halicoryne wrightii*
20. Plants not more than 4 cm high 23
21. Plants solitary; almost globular ..... *Valonia ventricosa*
21. Plants not solitary; club-shaped ..... *Boergesenia forbesii*
22. Plant spongy 24

22. Plant not spongy 26
23. Plants with rings near the base; gametangium oblong. *Neomeris annulata*
23. Plants lacking basal rings; gametangium more or less spherical. *Neomeris vanbosseæ*
24. Plant forming a lump, soft and unbranched .. *Codium arabicum*
24. Plant not lumpy, and branched 25
25. Branches long, few ..... *Codium tomentosum*
25. Branches short, numerous ..... *Codium intricatum*
26. Plant forming a rosette of bladelike structures; cells branching into a network ..... *Anadyomene*
26. Plants not as above 27
27. Plant ball-like, composed of several vesicles, and often lobed 28
27. Plant with conspicuous runners from which erect portions arise .. 29
28. Plants hollow, large and often ruptured at maturity. *Dictyosphaeria cavernosa*
28. Plants small, almost solid and not ruptured, even at maturity. *Dictyosphaeria intermedia*
29. Ramuli globose or subglobose 30
29. Ramuli compressed or cylindrical 31
30. Ramuli dominantly globose, very dense and small; rootlike structures few, rigid ..... *Caulerpa racemosa* 2
30. Ramuli subglobose, not as dense as above; rootlike structures numerous, lax ..... *Caulerpa racemosa* 1
31. Ramuli linear, toothed ..... *Caulerpa serrulata*
31. Ramuli entire, not toothed 32
32. Erect branches with opposite, flat branchlets which are constricted at the base, up to 1.7 cm high .. *Caulerpa crassifolia*
32. Erect branches more than 1.7 cm high 33
33. Erect branches feathery because of needlelike opposite branches. *Caulerpa sertularioides*
33. Erect branches with opposite sickle-shaped branchlets which are constricted at their bases ..... *Caulerpa taxifolia*

II. PHÆOPHYCEÆ

1. Thallus filamentous 2
1. Thallus not filamentous 3
2. Propagulum with two long arms; attenuated at the base. *Sphacelaria furcigera*
2. Propagulum broad or stout; stalk not attenuated at the base. *Sphacelaria tribuloides*
3. Thallus strongly appressed or flat on rocks ..... *Zonaria variegata*
3. Thallus not as above 4
4. Thallus bulbous, hollow ..... *Colpomenia sinuosa*
4. Thallus not bulbous and hollow 5
5. Plant reticulate ..... *Hydroclathrus cancellatus*
5. Plant not reticulate 6

6. Plants made up of simple, branched, terete thallus. *Chnoospora implexa*
6. Plant not as above 7
7. Thallus peltate 8
7. Thallus not peltate 10
8. Stalk of leaves angular 9
8. Stalk of leaves not angular ..... *Turbinaria sp. No. 16126*
9. Margin of leaves set with a few short teeth *Turbinaria trialata* var. *cacensis*
9. Margin of leaves set with many long teeth ... *Turbinaria turbinata*
10. Thallus flabelliform, unbranched, with inrolled margins .. 11
10. Thallus branched; margins not inrolled 12
11. Plants up to 4.5 cm high, 23 to 35 micra thick ..... *Padina* sp.
11. Plants more than 4.5 cm high, 37 to 63 micra thick 13
12. Thallus split into many small segments; made up of three layers of cells ..... *Padina pavonia*
12. Thallus split into a few larger segments; made up of 2 layers of cells ..... *Padina sanctae-crucis*
13. Plants with swollen vesicles or air bladders 14
13. Plants without swollen vesicles or air bladders 23
14. Vesicles distinct from fronds 15
14. Vesicles immersed in fronds ..... *Cystoseira articulata*
15. Fronds pinnatifid especially those near the base *Sargassum* sp. No. 98
15. Fronds not pinnatifid 16
16. Apex of fronds duplicated, cuplike ... *Sargassum* sp. No. 16316
16. Apex of fronds flat 17
17. Fronds costate 18
17. Fronds ecostate 19
18. Vesicles alate 20
18. Vesicles exalate ..... *Sargassum* sp. No. 97B
19. Cryptoblasts arranged almost in a line along the entire length of the fronds ..... *Sargassum* sp. No. 98
19. Cryptoblasts scattered all over the surface of the fronds. *Sargassum* sp. No. 97A
20. Secondary axis compressed or elliptic ... *Sargassum* sp. No. 96
20. Secondary axis terete 21
21. Vesicles solitary ..... *Sargassum* sp. No. 16256
21. Vesicles in clusters 22
22. Midrib of flat thallus percurrent ..... *Sargassum* sp. No. 95
22. Midrib of flat thallus evanescent ..... *Sargassum* sp. No. 94A
23. Thallus with a midrib ..... *Dictyopteris* sp. No. 103
23. Thallus without a midrib 24
24. Thallus 0.5 to 3.0 mm broad ..... *Dictyota cervicornis*
24. Thallus more than 3 mm broad 25
25. Apices of thalli acute ..... *Dictyota* sp. No. 105
25. Apices of thalli rounded 26
26. Thallus 1 to 6 mm broad ..... *Dictyota dichotoma*
26. Thallus more than 6 mm broad 27

27. Blades up to 19 micra thick ..... *Dictyota indica*
27. Blades more than 19 micra thick 28
28. Blades 28 to 30 micra thick ..... *Dictyota* sp. No. 106
28. Blades 39 to 45 micra thick ..... *Dictyota* sp. No. 101A

III. RHODOPHYCEÆ

1. Thallus calcified 2
1. Thallus not calcified 10
2. Thallus jointed or articulated 3
2. Thallus not jointed nor articulated 7
3. Thallus not more than 4 cm high, arcuate, especially near the apex. *Rhodopeltis borealis*
3. Thallus more than 4 cm high, not arcuate 4
4. Segments dominantly complanate 5
4. Segments more or less cylindrical throughout 6
5. Globular cortical cells up to 35 micra in diameter; terminal cells apiculate ..... *Galaxaura apiculata*
5. Globular cortical cells not more than 35 micra in diameter; terminal cells not apiculate ..... *Galaxaura arborea*
6. Cortical cells 35 micra in diameter; thallus pinkish on drying. *Galaxaura dimorpha*
6. Cortical cells not more than 10 micra in diameter; thallus slightly ashen or brownish on drying ..... *Galaxaura constipata*
7. Intergenicula (internode) sagittate ..... *Chcilosporum cultratum*
7. Intergenicula (internode) cylindric 8
8. Plants up to 1.2 cm high, epiphytic ..... *Jania rubens*
8. Plants more than 1.2 cm high, not epiphytic 9
9. Internodes of thalli up to 5 cm high ..... *Liagora hawaiiana* var. 1
9. Internodes of thalli more than 5 cm high ... *Liagora hawaiiana* s.s.
10. Thallus flat 11
10. Thallus compressed, cylindric, or spherical 16
11. Plants epiphytic ..... *Leveillea jungermannioides*
11. Plants not epiphytic 12
12. Flat thalli prostrate, with numerous tiny spines at the margins ..... *Rhodymenia spinulosa*
12. Flat thalli may or may not be prostrate, with marginal spines 13
13. Thallus not divided into segments, up to 3 cm high .... *Amansia* sp.
13. Thallus divided into segments, more than 3 cm high 14
14. Plants 5 to 7 cm high ..... *Chondrococcus hornemmani*
14. Plants more than 7 cm high 15
15. Ultimate branchlets needlelike; main axis 1 to 4 mm broad. *Halymenia harveyana*
15. Ultimate branchlets not needlelike; main axis more than 4 mm broad. 16
16. Main axis up to 15 mm broad; flabelliform; apices of branches strongly acute ..... *Halymenia harveyana* var. 1
16. Main axis over 15 mm broad; not flabelliform; apices of branchlets rounded ..... *Halymenia* sp.

17. Plant globular ..... *Botryocladia Kuckuckii*
17. Plant not globular 18
18. Thallus prostrate, compressed, with tuberculate proliferations. *Eucheuma edule*
18. Thallus not as above 19
19. Plants not more than 4 cm high ..... *Carpopeltis* sp.
19. Plants more than 4 cm high 20
20. Thallus prostrate, with pointed or needlelike ultimate branchlets. 21
20. Thallus not prostrate; ultimate branchlets may or may not be pointed, but are not needlelike 22
21. Ultimate branchlets stellate-spinous ..... *Hypnea nidulans*
21. Ultimate branchlets not stellate-spinous ..... *Hypnea charoides*
22. Branches tapering ..... *Gracilaria compressa*
22. Branches not tapering 23
23. Thallus compressed 24
23. Thallus cylindric 25
24. Central axis up to 1.5 mm broad ..... *Laurencia* sp.
24. Central axis more than 1.5 mm broad .... *Laurencia ceylanica*
25. Thallus prostrate 26
25. Thallus not prostrate 27
26. Ultimate branchlets tubular, numerous; central axis 1 mm in diameter ..... *Laurencia decumbens*
26. Ultimate branchlets knoblike or globular, few; central axis more than 1 mm in diameter ..... *Laurencia* sp.
27. Plants up to 6 cm high with few, short secondary branches. *Laurencia japonica*
27. Plants more than 6 cm high with numerous, long secondary branches. 28
28. Secondary axis up to 1 mm in diameter; ultimate branchlets 0.5 mm in diameter; whole plant more than 15 cm high. *Laurencia obtusa*
28. Height of plant less than 15 cm; sizes of secondary axis and ultimate branchlets more than in *L. obtusa*. *Laurencia ceylanica*

Class CHLOROPHYCEÆ
Order CLADOPHORALES
Family CLADOPHORACEÆ

CLADOPHORA FULIGINOSA Kutzing **Plate 2, figs. 17–19.**

Cladophora fuliginosa KÜTZING (1849) 515; YAMADA (1934) 43–44, fig. 8; GILBERT (1942) 75–76.

Blodgettia confervoides KÜTZING in Harvey (1858).

Plant forming tufted cushions or tangled filaments below low tide level, light to bright green. Filaments more or less cylindric, 72 to 141 micra diam., each segment 3 to 5 times longer than wide, with a relatively thick cell wall up to 58 micra.

Branching types various, dichotomous or in a simple unilateral arrangement along the main axis. Apices of branches rounded or obtuse and occasionally with rhizoidal filaments developed (this being a unique characteristic of the species). Branches dense.

CHAETOMORPHA BRACHYGONA Harvey.

Chaetomorpha brachygona HARVEY (1858) 87–88, pl. 46, figs. 1–2; GILBERT (1942) 87–88.

Thallus filamentous, cylindric, dull green or yellowish-green, entangled or intertwined. Filaments 104 to 130 micra diam., 52 to 78 micra long. Along the entire length of the filaments are long cells intermixed with shorter cells, while constrictions of individual cells are also slightly visible. Reproduction either by fragmentation or by flagellated zoöspores. The plant was found in a rolled mass floating on a mudflat, in a foot or less of water.

CHAETOMORPHA ANTENNINA (Bory) Kutzing.

Chaetomorpha antennina KÜTZING (1849) 379; GILBERT (1942) 84–85, pl. 5, figs. 1–2; BÖRGESEN (1940) 37–39.

Conferva antennina BORY, Voy. (1804) 161, pl. 2.

Chaetomorpha media (Agardh) KÜTZING (1849) 380.

Plant in tufts 7 cm high, unbranched, consisting of cylindric, subcylindric, or rectangular cells, the basal cell long, up to 3.5 mm high, about 0.1 mm broad, with a constricted or annular base. Thallus filamentous with a thick cell wall, attached by branching rhizoidal filaments. Vegetative cells 490 to 680 micra long, 280 to 330 micra broad. The plant was collected from a sandy-muddy substratum with a few larger rock particles and shell fragments, below low tide level.

Order ULVALES
Family ULVACEÆ

ULVA RETICULATA Forsskal.

Ulva reticulata FORSSKAL in Gilbert (1942) 35–36, pl. 1, figs. 9–10; OKAMURA (1912) 182–184, pl. 100, figs. 1–6.

Phycoseris reticulata KÜTZING (1856) pl. 29.

Thallus parenchymatous, with numerous perforations of various sizes, formed by the disintegration of cells. Margin entire, lobed, or sinuous, or sometimes toothed, with short spine-like protuberances, a few cells thick, as a result of the develop-

ment of the proliferations. Thallus in some specimens spiralled at the anterior end. Flat blade is linear, 2 cells thick, 55 to 64 micra; cell at margin usually solitary, about 11 micra broad. Cells of median part 13 to 29 micra high. In transverse section, cells composing thallus are of irregular form, predominantly rectangular. In surface view cells are polygonal, 9 to 18 micra broad, with a relatively thin wall. Plant is usually entangled with other algæ such as the Sargassums.

Order SIPHONALES
Family VALONIACEÆ

BOODLEA COMPOSITA (Harvey) Brand. **Plate 3, figs. 40–42.**

Boodlea composita BRAND in Fritsch, Op. cit. (1948) 421–422, 424, 439; GILBERT (1942) 55–56; EGEROD (1952) 361.

Cladophora composita HARVEY in Hooker, Journ. Bot. 1 (1834) 157.

Plant matlike, covering much of the bottom of a large pool. Thallus yellow-green, filamentous, more or less cylindric, segments 70 to 172 micra broad; branches septate, with or without crosswalls at the base; apex obtuse, rounded, sometimes developing rhizoids and becoming a holdfast. Branching system very irregular, basal part with few branches, becoming dense at apical portion; opposite, alternate, or radial type of branching present in one plant. Cell wall thin, ca. 3 micra thick.

VALONIA VENTRICOSA J. Agardh.

Valonia ventricosa J. AGARDH (1886) 96; EGEROD (1952) 347–348, pl. 29a.

Whole thallus a single large globular or subspherical vegetative pyriform cell, 2 to 4.5 cm diam., up to 4 cm high. Specimens were collected below low tide level from rocks; they were attached by a few short haptera developed from the base.

DICTYOSPHAERIA CAVERNOSA (Forsskal) Borgesen.

Dictyosphæria cavernosa BÖRGESEN (1932) 1–14, pl. 1; DECAISNE (1842) 297–380, pls. 14–17.

Ulva cavernosa FORSSKAL (1775) 187.

Dictyosphaeria favulosa (Agardh) DECAISNE (1842) 32.

Thallus of a layer of polygonal cells, with diam. ca. 1.5 to 4 mm. When young, the plant is a hollow ball-like structure, attached to the substratum by rhizoids arising from basal segments of the thallus. At maturity plants become ruptured, rolled inward, and from this area portions break off and become

new plants. In Egerod (1952) it is stated: "Elsewhere on the plant occasional segments become greatly inflated and, by the parietal orientation of the daughter segments within, soon form secondary monostromatic bladders attached to the parent bladder. They may remain attached to the thallus or break away and continue their development as independent plants."

DICTYOSPHAERIA INTERMEDIA Weber van Bosse.

Dictyosphaeria intermedia Weber Van Bosse, Siboga Exped. Monogr. 59a (1913) 64; Taylor (1950) 42–43.

Thallus a compact mass of polygonal cells, each with a diameter of ca. 150 to 550 micra, whole thallus spherical in general outline, somewhat flattened, attached to the substratum by a few rhizoidal filaments arising from the basal segments. Diameter of plant 4 to 15 mm; thallus of a single layer of isodiametric parenchymatous cells. Unlike *D. cavernosa,* the segments remain intact even at maturity. Rhizoids ca. 2 mm long, 300 to 435 micra diam., lacking a dividing wall. Specimens found fully below tide level, on rocks or in crevices.

ANADYOMENE WRIGHTII Gray.

Anadyomene Wrightii Gray (1866) 48, pl. 44, fig. 5; Weber van Bosse, Siboga Exped. Monogr. 59a (1900) 73–74, figs. 14–15; Börgesen (1940) 32–33, fig. 9.

Plant from 1 to 2.5 cm high; leaflike in habit; thallus of veins radiating from base, flabellately formed, the primary veins usually in pairs, continuous in growth, giving rise to other veins, and embedded within branchlets; branching polychotomous; veins septate; ultimate branchlets anastomosing and connected to each other, forming the foliar expanse. Branchlets small, short, assymetric in shape. Veins cylindric or subcylindric, narrow at base, wider at apex, the widest portion 150 micra broad. Plant rosettelike in habit, decumbent, attached to the substratum by thick-walled rhizoidal filaments. Margin of thallus sinuous. Color dark full green. Surface undulate.

BORGESENIA FORBESII (Harvey) Feldmann. **Plate 1, fig. 13.**

Borgesenia forbesii Feldmann (1938) 18, figs. 3–5; Gilbert (1942) 51–53; Börgesen (1948) 21–22.

Valonia Forbesii Harvey, Alg. Ceylon Exsicc. No. 75, and Friendly Islands Alg. No. 112.

Pseudovalonia Forbesii Iyengar, On Structure and Life History of *Pseudovalonia Forbesii* (1938) 191, figs. 1–4.

Thallus of clavate vesicles, attached to sandy-rocky substratum in small pools by short rhizoids coming from the prostrate branch. Height of thallus ca. 0.5 to 5 cm; diam. ca. 2 to 10 mm; base narrow, apex gradually broader, tip rounded. Basal branches of plant septate by segregative division, in groups, light green when living, greenish-yellow when dried.

Family DASYCLADACEÆ

BORNETELLA NITIDA (Harvey) Munier-Chalmas. **Plate 1, figs. 6–9.**

Bornetella nitida MUNIER-CHALMAS (1877) 814–817; GILBERT (1942) 25–26, figs. 1e–f.

Neomeris nitida HARVEY, List of Friendly Islands Algæ, No. 83 (1857).

Plants 10 to 28 mm high, cylindric to subcylindric clavate; attached to the substratum by several irregular rhizoids from the base of the central axis. Primary branches arising from the cylindric axis in a whorled manner. Sporangia globular, formed laterally on primary branches. Cortical cells calcified; central axis cartilagenous. Living material light to dark green with slight tinges of violet; dried specimens brittle, lustrous.

NEOMERIS VAN-BOSSEAE Howe. **Plate 1, figs. 4–5.**

Neomeris van-bosseæ HOWE, Bull. Torr. Bot. Club **26** (1909) 75–104, pls. 1–8; EGEROD (1952) 405–406, fig. 22b.

Plant heavily calcified, 1.5 to 4 cm high, 1.5 to 3 mm diam. Thalius cylindric, erect, slightly clavate, consisting of whorled laterals around a cylindric axis. Gametangia globose, ca. 203 micra diam., pedicillate, terminal on primary branches. Plant attached to substratum by short rhizoids at the base. Secondary branches arise, always in pairs, on a solitary primary branch.

NEOMERIS ANNULATA Dickie. **Plate 1, figs. 1–3.**

Neomeris annulata DICKIE (1874) 198; EGEROD (1952) 400–405, fig. 21.

Plant heavily calcified, composed of many laterals whorled around a cylindric axis. Oblong gametangium with a short stalk, borne terminally on primary branch, ca. 286 micra long, 130 micra broad. Thallus 1.5 to 4 cm high, 2 to 3 mm diam., erect, slightly clavate. Primary branches arise singly from central axis, with secondary branches always paired. Thallus attached to substratum by short rhizoids.

ACETABULARIA MAJOR Martens. **Plate 1, figs. 10–12.**

Acetabularia major SOLMS-LAUBACH (1895) 1–39, pls. 1–4; HOWE, Journ. Wash. Acad. Sci. (7) **22** (1932) 167–170; GILBERT, Pap. Mich. Acad. Sci. Arts. and Lett. **28** (1943) 29–30, pl. a–c.

Plant umbrellalike, the flat circular apex 17 to 32 mm diam.; 3 to 6 cm high, with a a heavily calcified cylindric stalk, less than 1 mm diam., formed of calcified fused rays. Superior and inferior corona present. Sporangial rays 71 to 91. Thallus attached to rocks, eel-grass stems, (even on live crustaceans) by a short (less than 1.5 mm long) series of irregularly branched rhizoids 52 to 150 micra diam. Plant found below low tide level in muddy substratum.

ACETABULARIA MINUTISSIMA Okamura.

Acetabularia minutissima OKAMURA (1912) 184–185, pl. 100, figs. 7–11.

Plant up to 4.2 cm high, diameter of umbrellalike apical structure ca. 4 mm. Disc rays 15 to 19. Apex rounded to truncate. Corona inferior not seen (according to M. S. Doty). Gametangial disc rays laterally connected to each other forming a flat circular structure, peltate on a short cylindric stipe. Plant found below low tide level on undersides of boulders, on protected side of Shell Island; holdfast disc-shaped, very small.

HALICORYNE WRIGHTII Harvey.

Halicoryne Wrightii HARVEY in GILBERT (1942) 110–112.
Polyphysa spicata KÜTZING, Tab. Phyc. (1866) 1, pl. 1, figs. c–f.

Plant linear or slightly clavate, 3 to 8 cm high, calcified. Branches whorled and of two types, fertile ones alternating with sterile ones. Thallus with a short stipe and a few short rhizoids at base. Central axis cylindric, hollow at the center. Texture of thallus cartilaginous after decalcification. Living plants green, always grouped. Plants found attached to shells, stems, twigs, and limestone rocks.

Family CAULERPACEÆ

CAULERPA RACEMOSA (Forsskal) Weber van Bosse, var. **1.**

Caulerpa racemosa WEBER VAN BOSSE (1898) 357; GILBERT (1942) 139–140.

Plant with erect branches, consisting of globose to subglobose ramuli, with rounded-subtruncate apices; base narrow, becoming inflated apically, pedicillate, ca. 1 mm long, alternately arranged along the cylindric upright axis, this 1.5 to 2 mm diam.

Stoloniferous prostrate branch somewhat larger in diameter than erect branches. Erect system 2 to 9 mm apart on stolon, 8 to 25 mm high. In this variety there are two forms, with slight differences which are worthy of mention, as they are prominently exhibited by both plants. In var. 1, No. 20-A, descending branches usually divide at the basal end into several secondary branches, each of which in turn emits long, very dense filamentous rhizoids reaching a length of 4.2 cm with a main stalk 1.6 cm long. Ramuli generally a little larger than var. 1, No. 20, which has shorter lateral secondary segments which develop branched, fine rhizoidal filaments less than 2 cm long.

CAULERPA RACEMOSA (Forsskal) Weber van Bosse, var. 2.

Caulerpa racemosa WEBER VAN BOSSE (1898) 357; GILBERT (1942) 139–140.

Fucus racemosa FORSSKAL (1775) 191.

Caulerpa clavifera C. AGARDH in Harvey (1858)

Ramuli globular, small, numerous, grapelike in appearance, forming a compact structure, shortly stipitate, developing verticillately along the entire length of the stalked, cylindric, erect or mainly upright axis, which is ca. 11 to 46 mm high. Erect system (in some of the specimens on hand) exhibits lateral branching with the same arrangement as the former, and also shortly stipitate. Prostrate branch stoloniferous, cylindric, 1 to 1.9 mm diam. and dichotomous. Descending branches emit long fine rhizoidal filaments, few in number. Color dark green.

CAULERPA SERTULARIOIDES (Gmelin) Howe.

Caulerpa sertularioides HOWE (1905) 576; GILBERT (1942) 133–134.

Fucus sertularioides GMELIN (1768) 154, pl. 15, fig. 4.

Caulerpa clavifera C. AGARDH in Harvey (1858).

Erect system branching, stipitate, with somewhat cylindric linear ramuli 2 to 6 mm long 0.1 to 0.25 mm diam., apically acute, pinnately arranged, opposite on the cylindric axis, distichous, curved toward the apex, unequal in length. Stoloniferous part cylindric, 0.3 to 1 mm diam., sparsely branched, developing a primary descending system, this also cylindric, with secondary branches up to 2.5 cm long having fine hairlike rhizoidal filaments. Specimens collected from a rocky substratum in a sandy area, below low tide level.

CAULERPA TAXIFOLIA (Vahl) C. Agardh.

Cauelrpa taxifolia C. AGARDH (1822) 435; WEBER VAN BOSSE (1901) 100.

Fucus taxifolius VAHL (1802) 36.

Plant composed of terete or subterete surculus, less than 1 mm diam., giving rise to upright branches which are somewhat cylindric at base and almost flat at point where ramuli develop. Upright branches ca. 2.8 cm high, composed of compressed ramuli with a short mucronate apex. Ramuli up to 4 mm long, 1 mm broad, spindle- or sickle-shaped, curved slightly inward toward tip, distichous on the upright branch. Plant attached by very fine long rhizoids arising from a cylindric primary rhizoid which goes from the ventral side of the surculus. Rhizoids usually alternate with erect branches, but some may be opposite. Thallus attached to rocks, in shallow water below tide level.

CAULERPA SERRULATA (Forsskal) J. Agardh, emend. Borgesen.

Caulerpa serrulata BÖRGESEN (1932) 1–14, pl. 1.

Fucus serrulatus FORSSKAL (1775) 189.

Erect thallus up to 6 cm high with a short cylindric stipe ca. 1 to 1.5 mm diam., where several compressed linear twisted and rugose ramuli originate. Margins of ramuli dentate or serrate. The prostrate stoloniferous branch dichotomizes or gives rise to further stolons, 1.5 to 2.5 mm diam. Cylindric descending branch emitted from stolon develops very short fine filaments on its surface and its basal region divides to form long secondary threadlike rhizoids. Surface of erect and prostrate system lucid, the latter smooth and unlike the erect system.

CAULERPA CRASSIFOLIA (C. Agardh) J. Agardh.

Caulerpa crassifolia BÖRGESEN, Kgl. Danske Vidensk. Selsk. Biol. Medd. (4) **22** (1954) 6–8, fig. 1; TAYLOR (1928) 96.

Caulerpa taxifolia crassifolia C. AGARDH (1822) 436.

Whole plant rather small, with the erect system up to 1.7 cm high, central axis not more than 1 mm wide. Ramuli opposite, distichous on the axis, 1 to 3 mm long, up to 0.8 mm broad, sickle-shaped, more or less compressed, with a short mucro at the apex. Erect branches lax, pedicillate, connected to the terete prostrate stolon. Stolon not more than 1 mm diam. Stoloniferous branch develops descending branches which emit fine rhizoidal filaments from the base.

Family CODIACEÆ

CODIUM TOMENTOSUM (Hudson) Stackhouse. **Plate 6, figs. 60–62.**

Codium tomentosum STACKHOUSE, Ner. Brit. (1801) 24; C. AGARDH (1822) 452; WEBER VAN BOSSE, Siboga Exped. Monogr. 59a (1913) 119; TAYLOR (1928) 81, fig. 16, pl. 6; fig. 4, pl. 7.

Plant prostrate on substratum, with slender cylindric thalli ca. 2 mm diam. Lower portion of plant anastomosing or dichotomous, upper part branched irregularly, dichotomously divaricate. Branches few, ca. 23 mm long. Plant attached to substratum by fine filaments arising from basal segments of thalli. Medullary filaments up to 37 micra diam. Utricles tubular or subclavate, 100 to 200 micra broad, 480 micra long; basal part narrow and usually becoming apically wider. Gametangia fusiform, 60 micra broad, up to 280 micra long. Utricle apices rounded or subtruncate.

CODIUM ARABICUM Kutzing. **Plate 6, figs. 58–59.**

Codium arabicum KÜTZING (1856) iv, 35, pl. 100, fig. 2; EGEROD (1952) 382–387, figs. 11a, 12, 13.

Codium coronatum SETCHELL var. insculptum SETCHELL (1926) 83.

Codium coronatum SETCHELL var. *aggregatum* BÖRGESEN (1940) 63, figs. 21–22.

Plant unbranched, applanate, spongy and convoluted at maturity. Whole thallus tightly appressed to substratum by fine rhizoidal filaments arising from ventral side of thallus. Medullary filaments of thallus 15 to 47 micra broad, several times longer than broad and intertwined. Utricles tubular, sometimes clavate or pyriform, 98 to 432 micra diam., 500 to 900 micra long. Utricle apices subtruncate or rounded with a very slight thickening near the tip. Young utricles arise like buds just below the apex of the mature utricles.

CODIUM INTRICATUM Okamura. **Plate 6, figs. 63–64.**

Codium intricatum OKAMURA, Icon. Jap. Alg. (4) 3 (1913) 74–75, pl. 120, figs. 9–13; GILBERT (1942) 168–169.

Thallus prostrate, dichotomously divaricate, cylindric, ca. 0.5 to 3.0 cm diam., matlike and attached to substratum by very fine rhizoids arising from the ventral side of the lower thalli, dispersed at different places without definite localization. Branches short; utricles tubular, with a round or truncate apex, ca. 93 to 208 micra diam., 115 to 531 micra long. Medullary

filaments intertwined, 31 to 52 micra broad. Margin of utricles slightly sinuous. Thallus attached to other thalli by fine filaments.

ADDENDUM

Family CODIACEÆ

AVRAINVILLEA OBSCURA J. Agardh. **Plate 3, figs. 30–34.**

Avrainvillea obscura J. AGARDH in Gepp & Gepp (1911) 20, 32.

Thallus flabelliform, shortly pedicellate, cuneate or subcuneate; plant (including holdfast) up to 12 cm high; found 8 cm broad, surface smooth like a soft cushion, made up of long cylindric nonseptate repeatedly dichotomous filaments, prominently deeply constricted directly above the dichotomy. End branches characteristically clavate; angle of branching flat, up to 44 micra broad. Thallus pluriseriate, thin and almost flat at the margins which appear gnowed because of the unequal lengths of frond filaments; thick at mid-central portion; elliptic in cross-section. Holdfast long, composed of fine dense branching rhizoidal filaments, attached to rock and sand particles forming a solid rounded structure; bulbous at base, reaching 7 cm long. Specimen was found solitary, not in groups, in a sandy-muddy substratum, below low tide level.

ADDENDUM

Family CODIACEÆ

CHLORODESMIS COMOSA Bailey et Harvey. **Plate 2, figs. 20–21**

Chlorodesmis comosa BAILEY et HARVEY in Gepp & Gepp (1911) 14–15, figs. 69–73; GILBERT (1942) 154–155, pl. 8, fig. 4.

Thallus filamentous, up to 7 cm high, cylindric, from 46 to 105 micra broad, flaccid, margin slightly sinuate; branches distant, dichotomous; angles between dichotomy acute or obtuse; branches above the dichotomy unequally deeply constricted; apices rounded. Tufts of filaments very dense, found in a rocky substratum, attached by a few branching rhizoidal filaments at the base. Plant light to dark green, the upper part becoming brownish upon drying. Plants collected below low tide level.

ADDENDUM

Family CODIACEÆ

UDOTEA ORIENTALIS Gepp & Gepp. **Plate 2, figs. 22–25.**

Udotea orientalis GEPP & GEPP (1911) 119, figs. 1, 4, 47–48; GILBERT (1942) 161–162.

Thallus calcified, flabelliform, composed of several layers of filaments which are more or less cylindric, branching dichotomously, destitute of branchlets or lateral appendages. Plant ca. 2.5 to 4 cm high; thallus 1.7 to 3.7 cm broad; plant attached to substratum by a bulbous basal structure made up of rhizoidal filaments conglomerated to form the holdfast. Filaments of frond constricted unequally just above the point of dichotomy; 26 to 34 micra broad. Filaments of stipe broader than those of frond; widest part 42 micra; short appendages developed, simple with rounded, truncate, or lobed apex. Plant light green; frond filaments distinctly visible; surface characteristically zonate at upper region.

AVRAINVILLEA SORDIDA Murray & Boodle. **Plate 3, figs. 35–39.**

Avrainvillea sordida MURRAY & BOODLE in Gepp & Gepp (1911) 21, 40, figs. 110–111.

Rhysilia longicaulis KÜTZING, Tab. Phyc. 8 (1858) 13, pl. 28, fig. 2.

Avrainvillea levis HOWE (1905) 565, pl. 23, fig. 1; pl. 26, figs. 8–10.

Plants with several flabelliform, reniform, cuneate, or suborbicular flat thalli, 3.8 cm broad, 3.5 cm high, pedicillate, arising from a short rhizomatous base, formed by conglomeration of fine branched rhizoidal filaments, these not over 3 mm broad. Fronds with a more or less cylindric stalk 1 to 2 mm diam. Surface zonate and spongy; margin may appear gnawed or sinuate because of the unequal lengths of filaments which compose it. Frond filaments 6 to 32 micra broad, nonseptate, torulose in some cases. Larger segments green, smaller ones nearly colorless or actually so. Angles between dichotomies rounded, obtuse, or flat. Dried specimens olivaceous, ashen, or greenish-brown. Plants found in sandy-muddy substratum below low tide level.

AVRAINVILLEA ERECTA (Berkeley) Gepp & Gepp. **Plate 3, figs. 27–30.**

Avrainvillea erecta GEPP & GEPP (1911) 20, 29, figs. 86–89; GILBERT (1942) 157.

Dichonema erectum BERKELEY in Hooker, Journ. Bot. (1842) 157, pl. 7, fig. 11.

Udotea sordida MONTAGNE (1844) 659.
Chloroplegma papuanum ZANARDINI, Nuov. Giorn. Bot. Ital. **10** (1878) 37.
Chlorodesmis pachypus KJELLMAN, Wittr. Nordst. Alg. Exsicc. No. 343 (1879), Bot. Not. (1880) 117.
Rhipilia Andersonii MURRAY, Trans. Linn. Soc. Bot. ser. 2 **2** (1886) 225, pl. 31.
Rhipidonema erectum SACCARDO, Syll. Fung. **6** (1888) 689.

Thallus flabelliform, shortly pedicillate, cuneate or reniform, up to 6.5 cm broad and 4.7 cm high from the tip to the end of the short thick stipe, this 8 mm wide and 1.5 to 2 mm thick. Surface of the fan-shaped thallus made up of long repeatedly dichotomizing nonseptate cylindric filaments with clavately formed end branches, measuring from 32 to 58 micra broad. Segments directly above the dichotomy prominently twice constricted, forming a beadlike structure. Angles of dichotomy commonly flat. Margin of flabellum gnawed owing to unequal growth of apical branches. Rhizoidal filaments conglomerate into a swollen cylindric tapering holdfast 5 cm long. Thallus dark brown with tinges of yellow and green. Plants usually found in a muddy-sandy substrate (with small sand particles) below low tide level.

HALIMEDA TUNA (Ellis & Solander) Lamouroux.

Halimeda tuna LAMOUROUX (1812) 181–188; BARTON (1901) 11–14, pl. 1, figs. 1–6; GILBERT (1942) 196–197, pl. 12, figs. 3–4.

Plants not as heavily calcified as *H. opuntia;* with large genicula of various shapes, up to 3.2 cm broad and 2.1 cm high; discoid, cuneate; some thalli reniform, with lobed, crenulate, or sinuous margin; branching di- or trichotomous. Base of thallus thick, subcylindric, with more or less wedge-shaped segments. Thickness of joints about 1 to 2.5 mm. Specimens on hand are fruiting, with black gametangial branches found on the surface and at the margins of the thalli. Plants in sandy-muddy substratum. Rhizoidal filaments form almost a solid holdfast. Utricles funnel-shaped, more or less truncate, ca. 35 micra broad, 55 to 75 micra long; one-eighth to one-sixth of the whole utricle is connected to the adjacent cortical utricle at the margin of the apex

HALIMEDA DISCOIDEA Decaisne. **Plate 4, figs. 47–50.**

Halimeda discoidea DECAISNE (1842) 102; GILBERT (1942) 177; EGEROD (1952) 397-398.

Plant erect, 5.5 cm or up to 12 cm high. Genicula flat, variously shaped—cuneate, discoid, ovoid, or some reniform; margin lobed, entire, or sinuate; up to 1.8 cm broad and 1.5 cm high; basal segment subcylindric, surface undulate; rhizoidal holdfast short. Central filaments fused, branching di- or trichotomous. Subcortical filaments much larger than cortical filaments. Surface of geniculum without midrib and somewhat lucid on drying. Utricles connected with each other through half their length. Apex of utricle rounded or truncate, 40 to 52 micra diam. Epidermal layer composed of polygonal cells, 40 to 52 micra diam.

HALIMEDA CUNEATA Hering, var. 1. **Plate 4, figs. 43–46.**

Halimeda cuneata HERING, FLORA (1846)) 214; GILBERT (1942) 181–182, pl. 12, fig. 2; BARTON (1901) 15–17, pl. 1, figs. 7–14.

Plants slightly calcified, up to 12 cm high, thallus flat, cuneate discoid or tubular. Apices orbicular, cuneate; margin entire, sinuate, or deeply lobed; branching di- or trichotomous, or polychotomous. Basal region somewhat solid and swollen. Fused central filaments show di- and trichotomous branching. Cortical utricles cylindric, connected through most of their length to adjacent utricles, swollen or wider at the apex, 17 to 28 micra broad, 40 to 50 micra high. Surface of cortical portion polygonal. Plants collected from sandy-muddy substratum below low tide level, held by dense rhizoidal filaments which form a solid mass. Surface of thallus dull dark green, whitish, or yellowish green upon drying.

HALIMEDA CUNEATA Hering, var. 2. **Plate 5, figs. 54–55.**

Halimeda cuneata HERING, Flora (1846) 214; BARTON (1901) 16.
Halimeda obovata KÜTZING, Tab. Phyc. 8 (1858) pl. 25, fig. 1.
Halimeda macroloba HARVEY (1860) 167.
Halimeda macroloba ASKENASY, Exp. S.M.S. Gazelle, IV. Bot. Alg. 14, pl. 3, figs. 6, 8–10, pl. 4.

Plants up to 9 cm high, slightly calcified; genicula reniform, cuneate or some orbicular. Largest geniculum 2.8 cm broad, 1.2 cm high. Genicula overlapping. Surface smooth, somewhat lucid on drying, 1 to 1.7 mm thick, the margin sinuate or entire, thickened. Branching di- or trichotomous. Lowest joint where branching occurs more or less wedge-shape. Stalk short, subcylindric. Rhizoidal holdfast formed by a very dense cluster of the filaments arising from the central axis. Surface of peripheral cells polygonal, ca. 49 micra broad.

Plants found in a sandy substratum.

HALIMEDA OPUNTIA Lamouroux. **Plate 5, figs. 51–53; 56–57.**

Halimeda obovata LAMOUROUX, Histoire des polypieres coralligenes flexibles... Caen 74 (1816) 599 pp.; 19 pls., 1 chart (1912) 186; BARTON 60 (1901) 18–22, figs. 19–27; GILBERT (1942) 190–199; EGEROD (5) 25 (1952) 397, pl. 37, fig. a, e, f.

Corallina opuntioides SLOANE, Nat. Hist. Jam. 1 (1707) 57, 16, pl. 20, fig. 2.

Corallina opuntia LINNAEUS, Syst. Nat. 1 (1760) 805.

Sertularia ramosissima LINNAEUS, Hort. Cliff. (1737) 480.

Flabellaria multicaulis LAMARCK, Ann. Mus. Hist. 20 (1813) 302.

Corallina latifolia et *Opuntia marina* PLUKENET, Phytogr. (1696) pl. 26, fig. 1, Almag. 118.

Thallus heavily calcified; flattened segments of various shapes, orbicular, ovate, or cuneate; ribs present but indistinct; branches radial; basal-central segment may give rise to six branches; next joint then branching three times and uppermost joints twice. Joints of various sizes, from 3 to 10 mm broad. Thalli at basal region overlapping, becoming separated at apex. Plant somewhat decumbent, composed of strongly calcified geniculum connected to each other by central filaments. Two filaments fuse at the geniculum. Surface of cells polygonal, 18 to 35 micra diam.

Class PHÆOPHYCEÆ

Order SPHACELARIALES

Family SPHACELARIACEÆ

SPHACELARIA FURCIGERA Kutzing. **Plates 10 and 12, figs. 105–108, 126–128.**

Sphacelaria furcigera KÜTZING, Tab. Phyc. 5 (1855) 27, pl. 90, fig. 11; BÖRGESEN, Kgl. Danske Vidensk. Selsk. Biol. Medd. (3) 16 (1941) 46, fig. 21; TAYLOR (1928) 105–106.

Plants in tufts, 0.5 to 1.0 cm high, found attached to shells and *Sargassum* stems below low-tide level. Thallus filamentous, up to 19 micra diam., polystichous, greenish-brown in color. Propagulum slender, with two long arms reaching a length of 520 micra; attached to a pedicel, 19 to 46 micra diam., slightly attenuated at base. Branches sparse, alternate on the central axis.

SPHACELARIA TRIBULOIDES Meneghini. **Plate 11, figs. 122–125.**

Sphacelaria tribuloides MENEGHINI in Vickers (1908) 42, pl. 26; TAYLOR (1928) 106, pl. 14, figs. 7–10; BÖRGESEN, Kgl. Danske Vidensk. Selsk. Biol. Medd. (3) 16 (1941) 41–42, figs. 18a–c.

Plants of erect rigid tufts, 1 to 1.7 cm high, on rocks below low tide level. Thallus basally brown, apically greenish-brown. Filaments polystichous, 30 to 46 micra broad, branching type various, dichotomous or pinnate in one axis. Propagulum very broad or stout, bearing two arms, attached to a pedicel of short cells.

Order PUNCTARIALES

Family ENCŒLIACEÆ

COLPOMENIA SINUOSA (Roth) Derb. et Sol. **Plate 12, fig. 134.**

Colpomenia sinuosa DERB. et SOL. in Börgesen (1914) 20–21, fig. 12; TAYLOR (1928) 110, pl. 7, fig. 1; pl. 19, figs. 3–4.

Asperococcus sinuosus BORY in Harvey (1852).

Ulva sinuosa ROTH (1806) 327, pl. 12, fig. a.

Encoelium sinuosum C. AGARDH (1822) 146.

Thallus smooth, inflated, hollow, lobate superficial cell layer with numerous globular chromatophores. Inner cells large, almost colorless. Plant small, ball-like, or as large as a fist. Specimens dried or living light-brown.

HYDROCLATHRUS CANCELLATUS Bory.

Hydroclathrus cancellatus BORY in Harvey, Phyc. Austr. 2 (1847) pl. 98, fig. 1. (?), (1858) 120–121; VICKERS (1908) 41, pl. 23, figs. 1–5.

Asperococcus clathratus J. AGARDH, Sp. Alg. 1 (1848) 75.

Encoelium clathratum AGARDH in KÜTZING (1849) 552.

Thallus compressed, almost flat, irregular in habit, sinuous, the margin generally inrolled. Thallus perforated with semicircular holes of different diameters with inrolled borders. Plants may sometimes appear like perforated ball-like structures when the margins become strongly inrolled. Plant brown, found attached to substratum on its ventral side.

CHNOOSPORA IMPLEXA J. Agardh. **Plate 12, figs. 134–136.**

Chnoospora implexa J. AGARDH, Fucoidearum (1848) 172–173; BÖRGESEN, Kgl. Danske Vidensk. Selsk. Biol. Medd. (3) 16 (1941) 63–65.

Sphærococcus implexus HERING in Kützing, Sp. Alg. (1849) 775.

Chnoospora obtusangula (Harvey) SONDER, Alg. Trop. Austr. 45.

Dictyota obtusangula KÜTZING, Tab. Phyc. (1866) 36, pl. 87.

Thallus terete, long, entangled, less than 1 mm diam., branching dichotomously, axils between dichotomies rounded, segments

widely forked. Apical branches numerous, irregularly and dichotomously branched. Branching distant basally, narrowed toward the apex.

Order DICTYOTALES

Family DICTYOTACEÆ

ZONARIA VARIEGATA (Lamouroux) Mert. **Plate 12, fig. 135.**

Zonaria variegata MERT. in Weber van Bosse, Siboga Exped. Monogr. 59a (1913) 175–176; BÖRGESEN (1914) 41–43, figs. 25a–c, (1914) 47–48; TAYLOR (1928) 124–125, pl. 15, figs. 22–25; pl. 17, fig. 4.

Dictyota variegata LAMOUROUX in Essai, 57, pl. 5, figs. 7–9.

Gymnosorus variegatus (Lamouroux) J. AGARDH, Anal. Algolog. 1 (1894) 11.

Plant crustose on rocks, attached by filamentous rhizoids, moniliform in some cases, borne on the ventral side of the flattened thallus. Outline of the fronds somewhat flabellate, 4 to 8 cm across. Cells near surface in transverse section squarish or rectangular, 5 to 9 micra thick, in a single layer, with several layers of larger cells within, these 35 to 75 micra long, 8 to 17 micra broad. Thallus 140 to 158 micra thick. Margins mostly inrolled. Plant light to dark brown, with visible vertical striations.

PADINA PAVONIA Lamouroux. **Plate 10, figs. 113–117; Plate 11, figs. 118–120.**

Padina pavonia LAMOUROUX in Harvey, Phy. Brit. Lond., Pt. 16 (1847) pl. 91, figs. 1–7; FRITSCH 2 (1952) 305–307, fig. 111-F.

Padina mediterranea BORY in Moree, 75.

Dictyota pavonia LAMOUROUX in Essai, 57.

Zonaria pavonia C. AGARDH (1822) 125.

Fucus pavonius LINNAEUS, Sp. Pl. 2 (1630).

Plants up to 13 cm high, attached to substratum by dense rhizoidal filaments. Thallus flat, cuneate, splitting into a number of segments, calcified on both surfaces, but only slightly at the apex. Base stupose and almost covered with epiphytes. Plant light brown above, darker basally. Thallus deeply incised, the divisions narrow, numerous. Blade in transverse section made up of 3 layers of rectangular cells of different sizes; 37 to 63 micra thick. Hairlines and reproductive structures present, alternate, forming concentric zones on the surface of the flat thallus.

PADINA SANCTAE-CRUCIS Borgesen. **Plate 10, figs. 109–112.**

Padina sanctæ-crucis BÖRGESEN (1914) 45–46, fig. 27a–c; TAYLOR (1928) 123, pl. 17, fig. 6.
Padina pavonia LAMOUROUX in Farlow (1876).
Padina pavonia LAMOUROUX in Harvey (1852).

Plant 12 cm high, 11 cm across, slightly calcified on both surfaces and attached to the substratum by a stupose base, this ca. 1 cm long. Thallus somewhat reniform, lobed, flat. Frond flabelliform, splitting when mature into segments. Margins strongly inrolled. Hairlines and reproductive structures arranged alternately, 2 to 5 mm apart. Blade in transverse section ca. 60 micra thick, made up of two layers of rectagular cells. Base with numerous epiphytic crustose coralline algæ, only a few at apex.

PADINA sp.

Whole thallus somewhat cuneiform, up to 4.5 cm high, splitting into several flat thin segments 23 to 35 micra thick; connected to a stupose base. Basal hairs extend several mm above the base. Fructifications spherical, dark brown, alternate with hairlines; both in concentric zones, 0.8 to 1.2 mm apart. Blade composed of three layers of variously shaped cells. Margin conspicuously inrolled.

DICTYOTA INDICA Sonder.

Dictyota indica SONDER in Taylor (1928) 120, fig. 12.

Fronds flat, 19 micra thick, 1 to 3 mm broad, narrow above and slightly broader at the base. Thallus regularly dichotomous, angle of dichotomy 65 to 90°, axils rounded, apex rounded. Plant up to 14 cm high, slightly twisted, upper segments light brown, basal portions dark brown, with epiphytic corallines on its surface. A few spherical sori may be found on the flat thallus located several mm from the apex. Perforations of the thallus may be present, but rarely.

DICTYOTA DICHOTOMA (Hudson) Lamouroux. **Plate 12, fig. 136.**

Dictyota dichotoma LAMOUROUX in Okamura Icon. Jap. Alg. (3) **3** (1913) 39–43, pl. 113, figs. 1–5; TAYLOR, Pap. Tortugas Lab., Carn. Inst. Wash. **25** (1942) 58–59; DAWSON (1950) 90–92.
Zonaria dichotoma HARVEY, Phyc. **9**: pl. 103.
Dictyota vulgaria KÜTZING, Tab. Phyc. **9** (1859) pl. 10.

Plant up to 10 cm high, attached to the substratum by a small basal disc. Fronds flattened, 21.8 to 48.5 micra thick, the widest part ca. 6 mm broad, basal, the apex narrowed.

Proliferations rare. Sori very dense and scattered all over the thallus, mostly located near the center. Thallus dichotomously branched; axil between dichotomies wide, rounded. Plant very light brown when dried.

DICTYOTA CERVICORNIS Kutzing. **Plate 12, fig. 133.**

Dictyota cervicornis KÜTZING in Taylor (1928) 117–118, pl. 16, fig. 17.
Dictyota fasciola LAMOUROUX (?) in Harvey (1852).
Dictyota acutiloba C. AGARDH in Farlow (1875).

Fronds slender, 0.5 to 2.0 mm broad, narrow in the upper part, broader basally. Flat segments irregularly dichotomizing, angles of dichotomy 60 to 90°, axils rounded and the apices acute or rounded. Plant up to 12 cm high, found entangled with other brown algæ; lower branches bear epiphytic ceramia and corallines. Thallus in transverse section 11.5 micra thick; each cell 5.5 to 6 micra broad; blade consisting of a double cell layer. Spherical or globular sori found on flat frond surface; few in number.

DICTYOTA sp.

Plant up to 9 cm high, attached by rhizoidal filaments to the substratum. Thallus regularly dichotomous. Flattened segments 2 to 9 mm broad, 28 to 30 micra thick, with numerous circular open cryptostomata, 0.2 to 0.5 mm diam. on both surfaces. Thallus brown, with rounded or mucronate apex; axils between dichotomies rounded. Epiphytic corallines very dense near base, few present on upper segments. Perforations few. (No. 106.)

DICTYOTA sp. **Plate 11, fig. 121.**

Thallus flat, 10 cm high, yellow-brown, 3 to 10 mm broad, 41 micra thick, blade in transverse section made up of two layers of rectangular cells, 9 to 11 micra broad, midportion becoming hollow at maturity. Flat segments almost equal in size from base toward apex, except where branching occurs. Plant regularly dichotomous, with rounded or truncate apex; axil of dichotomies rounded, forking at 30 to 70° angle. Perforations present, few. Epiphytic corallines and ceramia may be found at the basal segments. Sori mostly near the base. (No. 101A.)

DICTYOTA sp. **Plate 12, fig. 132.**

Thallus up to 11 cm high, attached to the substratum by thin rhizoidal filaments. Segments flattened, 3 to 12 mm broad, with numerous spherical dark brown elevated sori, found scattered

all over the surface. Plant regularly dichotomous 25 to 90°, narrow at the anterior end with rounded axils. Apices of branches acute; upper segments yellowish-brown, becoming darker toward the base. Perforations present but very few. Crustose corallines may be found on the basal thalli. (No. 105.)

DICTYOPTERIS sp.

Plant erect, up to 28 cm high with numerous dichotomous branches, these very irregular. Thallus flat, thin, lax, with a conspicuous percurrent midrib, without veins or veinlets, 4 to 20 mm broad, the margin entire or slightly repand, apex mostly rounded. Branches arising at margins of flat segments or at their apex. Reproductive structures borne in sori, found in line on frond surface. Whole thallus attached to substratum by fine rhizoidal filaments formed on the short stem of the base. (No. 103.)

SARGASSUM sp. **Plate 9, figs. 100–101.**

Mature plants up to 70 cm high, attached to substratum by an extended conical base. Primary stem subterete, rugose, short, ca. 1 cm long, with numerous leaf or branch-scars, giving rise to secondary branches, these fasciculate around the main stem. Only two of the latter become persistent up to maturity. Axis slightly compressed, 2 mm broad at base, narrowing apically. Numerous branchlets developed alternately from the secondary stem. Axis of secondary stem also compressed, less than 1 mm broad. Fronds linear-lanceolate, 7 to 30 mm long, 1 to 4 mm broad, the margin crenulate, sinuate or dentate, those near the base broader, up to 8 mm wide; bases and apices acute. Cryptoblasts conspicuous, scattered all over the surface of the flat fronds, mostly located near the percurrent midrib. (No. 95.)

SARGASSUM sp.

Whole plant 20 cm high, attached to substratum by rhizomatous base. Primary stem subterete, very short, 4 mm long, 3 mm diam., rugose, with two subapical secondary branches becoming persistent at maturity. Secondary rachises similarly subterete and rugose, 1 to 2 mm diam., giving rise to several branchlets alternately arranged on axis, 0.6 to 1.4 mm diam. Fronds lanceolate to oblanceolate, margin irregularly dentate or crenate, with a rounded apex and acute base, 3 to 30 mm long, 3 to 8 mm broad; midrib percurrent or nearly so; open cryptoblasts conspicuous, mostly located on the middle part, rarely on

the margin. Inflated vesicles few, globular, 0.7 to 4 mm diam., stipitate, alate, with a few cryptostomata and developed at the base of the fronds. Receptacles clavate, very usually (judging from material in hand) solitary.

SARGASSUM DUPLICATUM J. Agardh.

Sargassum duplicatum J. AGARDH in Okamura, Icon. Jap. Alg. 5 (1928) 10-11, pl. 205, figs. 1-8.

Sargassum ilicifolium var. *duplicatum* J. AGARDH, Sp. Alg. (1822) 318-319.

Sargassum cristaefolium HARVEY in Hooker, Journ. Bot. 1 (1834) 147.

Fronds dominantly oblique, oblong-ovate, almost subspathulate; margin irregularly dentate; base acute; apex duplicated and cup-shaped; midrib evanescent. Maximum frond length 15 mm, breadth 7 mm. Frond surface set with numerous cryptostomata. Secondary rachises terete or subterete, less than 1 mm diam. Branchlets short, alternate. Vesicles few, globular-spherical, stipitate, 1 to 2 mm diam., formed at the base of receptacles, but higher than these, with a few scattered cryptosomata. Receptacles minute, developed at the base of the fronds, several in each stalk, never solitary. Specimen on hand is fragmentary, and specific placement was difficult and is somewhat tentative. It tallies with this species in many ways, except that the vesicles of our specimen are not alate, and the filiform stem is not more than 1 mm in diameter. (No. 16316.)

SARGASSUM sp. **Plate 9, figs. 95-99, 97a.**

Mature plants up to 40 cm high, attached to substratum by a small conical holdfast at the base. Primary stem subterete, with several wartlike structures on its surface, as a result of defoliation at maturity; 2 mm diam., 2 cm long, giving off fasciculately arranged branches, of which only 1 to 3 develop to maturity. Secondary branches flat; those below give rise to short pedicillate lanceolate pinnatifid and irregularly dentate fronds, with a percurrent midrib; 1 to 4.5 cm long, 3 to 8 broad; cryptoblasts numerous, especially near the margin; apex acute. Branches above denser distichous; alternate, with flat rachises; producing very few pedicellate, ecostate lanceolate or oblanceolate fronds 1 cm long, 1 to 1.5 mm broad; cryptoblasts present but few, superficial; margin crenulate, apex acute. Upper branches almost destitute of fronds in the fully grown plant. Receptacles stipitate, 0.2 to 1.0 mm long, 0.2 to 0.35 mm broad, short cylindric clavate, dichotomous, numerous, axillary and

terminal. Vesicles subspherical or globular, 0.5 to 1.5 mm diam., formed between the base of the vesicle and its stalk; a few cryptoblasts may be found on its surface. Awned or winged vesicles rare. (No. 98.)

SARGASSUM sp.

Mature plants up to 100 cm high, attached to substratum by a basal flat disc. Primary rachis subterete, rugose, with several scars left by branches or leaves shed at maturity; 1.5 to 5 mm long, not over 2.5 mm diam., producing several branches in a fasciculate manner, but only one dominantly persistent and growing to a considerable height. Secondary branches terete or subterete, 1 mm or less in diam., emitting terete branchlets arranged alternately on the secondary rachises. Ultimate branchlets short; fronds flat, minute, lacking a midrib, up to 12 mm long, 2 mm broad, oblanceolate, the margin sinuous; cryptoblasts present, few, but conspicuous, arranged linearly near the margin. Vesicles numerous, globular, stipitate with a few cryptoblasts on the surface, growing higher than the receptable. The latter are tubular, clavate, simple, solitary, and sessile.

SARGASSUM sp.

Mature plants up to 60 cm high, attached to the substratum by a compressed discoid base. Primary rachis subterete, rugose, short, with a few cryptoblasts ca. 1 cm long. Secondary branches fasciculately arranged on the main axis, 2 to 3 mm diam. of which 2 to 4 become persistent up to full maturity. Flat, stipitate, filiform fronds of the subterete secondary branch are dominantly linear at the upper portion, with several lanceolate fronds at the base, up to 40 mm long, 2.5 mm broad; margins serrate, tips and bases acute, with several large conspicuous cryptoblasts, almost linear on both sides of the evanescent midrib. Leaves above filiform, very few; vesicle numerous, subspherical, globular, with long stipes, attached at the bases of axillary receptacles, which are long, tubular, rugose, rarely clavate, branching 1 to 3 times dichotomously and higher than the solitary vesicles.

SARGASSUM sp.

Mature plants up to 53 cm high, attached to the substratum by a discoid base. Stem of primary shoot terete-subterete, 1.8 to 2.0 mm long, with a few secondary branches fascicu-

lately arranged on the primary stem. Two of the secondary shoots become persistent up to maturity; main axis compressed, 4 mm broad becoming apically narrower. Branchlets alternate, also with compressed axis, where alternate ultimate branchlets arise. Fronds dense, linear stipitate, margins sinuate, apices, and bases acute, 1.8 to 5.0 mm long, alternate. Fronds near the base lanceolate, few. Frond surfaces set with large conspicuous cryptoblasts, linearly arranged, nearly parallel to the evanescent midrib. Vesicles globular or subspherical, axillary, petiolate, with a few large cryptoblasts on its smooth surface. Receptacles few, tubular or clavate and axillary.

SARGASSUM sp. **Plate 9, fig. 102.**

Mature plant up to 57 cm high, attached to rocks by a flat discoid base. Primary stem terete, smooth, ca. 5 mm long, a little more than 1 mm diam. Branches of secondary shoot whorled and only one or two persistent until maturity; main axis slightly angular or subterete, less than 2 mm broad, giving rise to branchlets with a short axis, less than 1 mm broad, alternately arranged; ultimate branchlets may be developed from the latter. Fronds oblanceolate, obovate; margins dentate, bases acute, apices obtuse; 8 to 30 mm long; cryptoblasts present, scattered on the surface; fronds near the base larger than those above, and with an evanescent midrib. Vesicles globular or subspherical, pedicellate, few alate, axillary, with a few cryptoblasts on the surface. Receptacles few, axillary, tubular, or clavate, and dichotomously branched. (No. 94-A.)

SARGASSUM sp.

Plant up to 35 cm high, attached to the substratum by an expanded base appressed to rocks. Primary stem subterete, rugose, nodose, short, less than 1 cm long. Secondary shoots several, but only two becoming persistent up to maturity; main axis slightly angular, 1 mm or less in breadth; becoming narrowed anteriorly. Branchlets arranged alternately on the subterete secondary stem, less than 1 mm broad. Fronds ecostate, linear, a few oblong-oblanceolate; margins sinuate and some dentate; apices rounded; bases acute. Cryptoblasts on frond surfaces, few and scattered. Vesicles axillary, globular or spherical, with a few cryptoblasts on the smooth surface. Alate vesicles rare. Receptables clavate or tubular, alternate or dichotomously branched.

TURBINARIA TRIALATA var. CAPENSIS Kutzing.

Turbinaria trialata var. *capensis* KÜTZING, Tab. Phyc. **10** (1860) pl. 67, fig. 67 (2).

Plants erect, up to 12 cm high from the base. Leaves angular, petiolate, alternate. Expanded part of leaf 5 to 12 mm broad; margins set with short teeth; central part subconvex. Cryptostomata on thallus numerous and very conspicuous. The specimens on a rock top near the low-tide line.

TURBINARIA TURBINATA (Linn.) Kuntze.

Turbinaria turbinata KUNTZE in Taylor (1928) 131, pl. 18, fig. 13.
Turbinaria vulgaris C. AGARDH in Farlow (1876).

Plants erect, up to 10 cm high from the holdfast. Leaves more or less inflated, petiolate, alternate on the terete-subterete stem; 3-angled, distal end expanded; margin set with long teeth, central part convex; large open cryptostomata may be on the surface. Receptacles clavate, numerous, clustered together.

TURBINARIA sp.

Plant erect, ca. 12 cm high, attached to the substratum by a flattened discoid base connected to a short terete stem. Central axis slightly compressed, smooth. Branches short, arranged alternately on the main axis. Expanded part of leaves up to 20 mm broad, orbicular, dentate; base peltate, united with a somewhat angular stipe, 12 mm long, with numerous elevated cryptoblasts on the surface, located mostly near the margin. Receptacles few, tubular, clavate and loosely branched. Specimens light brown on drying. Plant found growing among coelenterate corals in a dense coral bed. (No. 16126.)

Family CYSTOSEIRACEÆ

CYSTOSEIRA ARTICULATA J. Agardh.

Cystoseira articulata J. AGARDH, Sp. Gen. Ord. 1 (1848) 216; OKAMURA (1913) 47, pl. 114, figs. 1–5.
Hormophysa articulata KÜTZING, Tab. Phyc. **10** (1860) 22, pl. 61.
Hormosira? articulata ZANARDINI, Plant. Mari Rubra, 243, No. 35.

Plant up to 35 cm high, attached to the substratum by a flattened discoid base connected to a short stem, terete, 3 mm diam. becoming narrower apically. Flattened segments with branches at its margins and axis. Bladders elliptical, alate 2 to 3 times, wings dentate, 5 to 25 mm broad. Conceptacles with the female and male structures numerous, found on sur-

faces of the wings and some on the elliptical air-vesicles. Plants dark-brown.

Class RHODOPHYCEÆ
Sub-class FLORIDEÆ
Order NEMALIONALES
Family HELMINTHOCLADIACEÆ

LIAGORA HAWAIIANA Butters, var. 1. **Plate 7, figs. 83–84; Plate 8, figs. 87–88.**

Liagora hawaiiana BUTTERS in Abbott (1945) 151–153.

Thallus regularly divaricately dichotomous, terete, heavily calcified except at the apex. Thallus not over 1 mm diam., ca. 6 cm high. Filaments of central axis 8 to 20 micra broad, compactly arranged. Assimilatory filaments of different forms; lower ones long and cylindric upper, segments shorter, ovate, elliptical, or rectangular; branching dichotomous. Carpogonial branch originates from the lateral edge of the assimilatory cells. The former is straight or nearly so, composed of 3 to 4 cells. A long trichogyne is usually present at the tip of the carpogonial branch. Crystocarp covered with almost cylindric, dense, involucrelike filaments. Carpospores are relatively large and cylindric. Plants found attached to rocks, by a short cartilaginous stipe forming a flat disc at the base, below low-tide level.

LIAGORA HAWAIIANA Butters. **Plate 7, figs. 81–82.**

Thallus cylindric, up to 7 cm high, heavily calcified, regularly dichotomous, tapering toward the apices. Whole plant attached to substratum by a flat discoid base connected to a short cartilaginous terete stipe not over 2 mm long. Segments less than 1 mm diam., 3 to 6 mm long, surface with numerous proliferations. Apices slightly compressed; axils between dichotomies rounded or obtuse. Central axis composed of more or less cylindric cells, broad at one end and narrow at the other, 21 micra diam. (at the widest part), 130 to 325 micra long, dichotomously branched; secondary segments also cylindric, but shorter and narrower than the former. Ultimate branches on the assimilatory filaments. Slightly curved carpogonial branches are developed on the mid-lateral portion of assimilatory cells, consisting of four cells, the apex of which emits long whiplike trichogyne; involucral filaments absent. Carpospores numerous, elongate, rod-shaped, or oval.

Family CHÆTANGIACEÆ

GALAXAURA ARBOREA Kjellman. **Plate 7, figs. 76, 78.**

Galaxaura arborea KJELLMAN in Chou (1944) 50–51, pl. 5, figs. 1–5; pl. 10, fig. 1; TANAKA (1936) 161–162, pl. 11, figs. 24–25.

Plants up to 8 cm high with erect branches, attached to substratum by a discoid base connected to a subterete stipe ca. 4 mm long. Thallus complanate or flattened throughout, divaricately dichotomous, obtuse or acute at angles of dichotomy, apices rounded-obtuse, rarely acute. Compressed segments 1 to 20 mm broad, basal portion wider, 2.5 to 3.0 mm broad, 5 to 9 mm long. Medullary filaments branching, 5.5 to 13.0 micra broad, with oval, spherical, or globular cortical cells, 41 to 78 micra broad, terminated by one or two elongate globular, oval, or spherical terminal cells, 15 to 42 micra broad, attached to a unicellular stalk 26 micra long, 6 micra broad.

GALAXAURA CONSTIPATA Kjellman.

Galaxaura constipata KJELLMAN (1900) 63-64, pl. 8, figs. 29-33.

Branches very dense, erect, up to 10 cm high, attached to substratum by a short slightly calcified subterete rugose stipe ca. 2 mm long with a more or less discoid base. Thallus terete, except the uppermost complanate segments; regularly dichotomous; surface slightly undulate, segments 4 to 8 long, 1.2 mm diam. at the most, with numerous porelike proliferations. Medullary filaments 4 to 11 micra broad, dichotomously branched, with ultimate branches terminated by two globose-subglobose cells forming the cortical tissue, 4 to 7 micra broad, each with two cells similar to its shape, 4 to 9 micra broad on the apex. Epidermal layer made up of polygonal cells, 8 to 16 micra broad, easily peeled off after decalcification.

GALAXAURA DIMORPHA Kjellman. **Plate 7, figs. 65–68, 73–75.**

Galaxaura dimorpha KJELLMAN (1900) 63, pl. 8, figs. 25–28.

Plants up to 9 cm high with erect branches, attached to substratum by a thin compressed cartilaginous structure; thalli terete throughout except the uppermost segments which are more or less complanate; regularly dichotomous; surface slightly undulate, segments, 3 to 10 mm long, 1 to 2 mm in diameter with a few porelike proliferation. Medullary filaments 3.45 to 17.25 micra broad, alternately or dichotomously branching with ultimate branches terminated by two spherical or subglobular cells up to 34.5 micra broad, with one or two smaller

cells, more or less the same in shape, 19 micra broad. Epidermal layer made up of polygonal cells, 5.75 to 17.5 micra broad; easily peeled off after decalcification.

GALAXAURA APICULATA Kjellman. **Plate 7, figs. 69–72.**

Galaxaura apiculata Kjellman (1900) 74–75, pl. 12, figs. 13–29; Tanaka (1936) 162–163; Chou (1944) 51–52, pl. 5, figs. 13–19.

Plants up to 7 cm high, made up of erect branches, attached to substratum by a stout rhizoidal holdfast, developed at the base of a short subterete stipe 4 mm long. Thallus complanate or flattened throughout, dichotomously branched, divaricate; angles between dichotomies acute or obtuse; apices rounded or obtuse. Articulate flattened segments 1 to 2 mm broad, 4 to 8 mm long. Medullary filaments 4 to 18 micra broad, dichotomously branched. Cortical tissue made up of large irregularly shaped cells, terminated by one or two oval or globular cells, 23 to 32 micra broad with a few apiculate, connected to a unicellular stipe.

Order CRYPTONEMIALES
Family CORALLINACEÆ

CHEILOSPORUM CULTRATUM (Harvey) Aresch.

Cheilosporum cultratum Aresch. in J. Agardh, Sp. Alg. (2) 2 (1852) 545–6; Yendo, Journ. Coll. Sci. Imp. Univ., Tokyo 12 (1905) 20; Manza (1940) 293–294.

Amphiroa cultrata Harvey, Ner. Austr. (1847) 102, pl. 39, figs. 1–3.

Plant ca. 5 cm high, calcified and reddish when dry. Thallus dichotomously branched, branches of the apex flat or compressed and those of the base cylindric. Intergenicula sagittate (like the specimen described by Manza, in his "Articulated Corallines," p. 293). Conceptacles are found on the upper ends of the intergenicula along the margin, usually one on each side.

JANIA RUBENS (Linnaeus) Lamouroux. **Plate 8, fig. 89.**

Jania rubens Lamouroux in Manza (1940) 272-273.

Corallina rubens Linnæus (1767) 1305.

Plant epiphytic on *Sargassum* stems, heavily calcified, ca. 1.2 cm high. Branching regularly dichotomous, branch apices acute, dichotomously bifurcate; genicula ca. 0.2 mm broad, 0.3 to 0.6 mm long, strongly calcified; intergenicula tubular, slightly calcified. Swollen solitary conceptacles arise at the apices

of the branches. Anterior part of each geniculum wider than its base. Algæ occur in dense tufts around the substratum, attached by short rhizoidal filaments emitted from the base.

RHODOPELTIS BOREALIS Yamada.

Rhodopeltis borealis YAMADA (1931) 75, pl. 19, fig. 1.

Plant calcified, regularly dichotomizing, ca. 4 cm long, 3.5 mm broad, segments basally narrowed, apically broader. Thalli compressed, purplish or greenish, flabelliform, arcuate especially at the apex. Main stem 2 mm long, subterete, connected to a discoid base which serves as holdfast. Specimens were collected in neap ramps, below low-tide level, and in a more or less shaded place.

RHODOPELTIS (?) GRACILIS Yamada & Tanaka. **Plate 7, figs. 79–80.**

Rhodopeltis gracilis YAMADA (1935) 30–32, pl. 15, fig. 2, text fig. 1.

Plants 4 to 9 cm high, leathery when dry, attached to the substratum in small isolated tufts by a compressed cartilaginous structure which is connected to a short (1 mm long) stipe. Thallus flat, purplish, dichotomously branched. Branches near base few, denser at apex. Compressed fronds wide basally (max. width 5 mm), narrowed above and tapered at the apices. Cells found at periphery small, oval to these large, usually pyriform, up to 80 micra long, 41 micra broad. Only the outermost part is encrusted with white chalky material.

Family GRATELOUPIACEÆ

HALYMENIA HARVEYANA J. Agardh.

Halymenia harveyana J. AGARDH in Okamura, Icon. Jap. Alg. 4 (1923) 42–44, figs. 1–3.

Halymenia floresia J. AGARDH, Phyc. Austr. 4: pl. 219.

Plants 14 cm high, with compressed fronds; main axis 1 to 4 mm broad; branching pinnate, but alternate on main axis; thallus narrow at the apices, more or less pointed; angles where branches arise rounded. Ultimate branchlets linear, short, alternate-pinnate. Plant purplish when dry, dark red when fresh, attached on rocks by a discoid base below low-tide level. Specimens slippery when fresh.

HALYMENIA HARVEYANA J. Agardh, var 1.

Plant ca. 23 cm high, with compressed fronds; main axis 5 to 15 mm broad; fronds narrowed toward the apices, which

are strongly acute; angles where branches occur acute or rounded; ultimate branches relatively broad, narrowing to a point toward the apex, pinnately branched, alternate; ultimate branchlets minute. The plants found below low-tide level, attached on rocks by a flattened discoid base which is attached to a short compressed stem 4 mm broad, less than 1 mm long and thick. Plant yellowish-green, with patches of red, when dry. In living condition the plant is dark red.

CARPOPELTIS sp.

Plants up to 3.5 cm high, di- or trichotomously branched fronds strap-shaped or ligulate, with rounded or truncate apex, 1 to 2.5 mm broad. Margin of the compressed thalli often sinuous; subapical parts slightly narrower than base and apex. Small ligulate branches are developed from the surfaces of the smooth fronds, rarely at the margins. Angles where branches occur, usually rounded, sometimes acute. Plants are found on rocks on intertidal neap ramps, attached to substratum by a discoid base on a short subterete stalk.

CHONDROCOCCUS HORNEMANNI (Mert.) Schitz.

Chondrococcus hornemanni SCHITZ. in Okamura, Icon. Jap. Alg. 4 (1923) 158-159, pl. 190, figs. 1-4.

Desmia hornemanni J. AGARDH, Sp. Alg. 2 (1852) 64.

Desmia coccinea ZANARDINI, Plant. Mari Rubra 55: pl. 9, fig. 1.

Plant ca. 7 cm high, in tufts. Primary and secondary branches, 2 mm broad; ultimate branchlets less than 1 mm broad. Branches forming an irregular dichotomy or at some part of the plant, branching may be pinnate. Whole plant is flabelliform. Thallus is attached to the substratum by a flat cartilaginous base. Plant bright red.

Order GIGARTINALES

Family SOLIERACEÆ

EUCHEUMA EDULE (Kutzing) Weber van Bosse.

Eucheuma edule WEBER VAN BOSSE (1928) 422–423, pls. 15, 16, figs. 5, 170.

Chondrus edulis KÜTZING, Tab. Phyc. 17 (1867) 19, pl. 63, figs. c–e.

Plant prostrate on rocks, attached at the underside by numerous small, flat discoid holdfasts. Thallus compressed, warty, or rugose with numerous tuberculate proliferations on dorsal surface and margin; divided by an indefinite branching

system; branches seemingly at different parts of the thallus forming a netlike entangled structure. The plant is thick, cartilaginous when dry, fleshy and gelatinous in living condition. Main axis from 5 to 15 mm broad and 2 to 5 mm thick. Color various; some parts yellowish-green, others violet or slightly purplish.

Family HYPNEACEÆ

HYPNEA NIDULANS Setchell. **Plate 7, figs. 85–86.**

Hypnea nidulans TANAKA (1941) 246–247, figs. 18–19; SETCHELL (1924) 161.

Thallus ca. 4 to 6 cm high; 0.5 to 1.9 cm broad; slightly subterete, cartilaginous; percurrent; primary and secondary branches dividing alternately or dichotomously; ultimate branchlets stellate spinous. In Tanaka's "The Genus *Hypnea* from Japan" (1941) he describes "lenticular thickenings in the walls of the medullary cells present; nemathecia saddle-shaped on side of the branchlets; tetraspores irregularly zonate; cystocarps and antheridia unknown." Central cells of transverse section large; cells becoming smaller toward the periphery. Hairs present, coming from peripheral cells. Thalli loosely intricate, forming a loose cushion on substratum.

HYPNEA CHAROIDES Lamouroux. **Plate 8, fig. 91.**

Hypnea charoides LAMOUROUX in Tanaka (1941) 243–245, figs. 16a–c.

Hypnea seticulosa J. AGARDH, Sp. Alg. 2 (1852) 446.

Thalli prostrate on sandy substratum; branches alternate, anastomosing or dichotomous; membranaceous, cylindric or subcylindric; apices pointed; main axis with numerous short spinelike branchlets, alternate, verticillate on the axis. Primary branch less than 1 mm diam. Central cells large in cross-section, becoming smaller toward the periphery; small peripheral cells 1 to 3 layers only. Filiform branchlets dark red, the rest light red. Plant is attached to rock particles, below low-tide level.

Family GRACILARIACEÆ

GRACILARIA COMPRESSA (Agardh) Greville.

Gracilaria compressa GREVILLE in Okamura, Icon. Jap. Alg. 5 (1928) 160–161, figs. 5–10.

Sphaerococcus compressa AGARDH in Kützing (1849) 774.

Thallus cylindric, cartilaginous, smooth, wide at base and tapering toward apex; 1 to 2 mm diam., up to 10 cm high. Branching mode various; irregularly dichotomous, trichotomous, or alternate; branches at the base few, but dense toward the apex. Some short branchlets emitted from secondary axis. Inner layer of the thallus consist of large semi-polygonal and oval-shaped cells, 156 micra broad. At the periphery are small rounded or oval cells, 1 to 3 layers in thickness, 4 to 12 micra broad; cell wall about 3 to 5 micra thick. Holdfast discoid.

Order CERAMIALES

Family RHODOMELACEÆ

LEVEILLEA JUNGERMANNIOIDES (Martens et Hering) Harvey.

Leveillea jungermannioides HARVEY, Mar. Bot. Austr. (1855) 539; OKAMURA (1929–1932) 11, pl. 256, figs. 13–15; BÖRGESEN, Kgl. Dansk. Vidensk. Selsk. Biol. Medd. (4) **20** (1945) 42–43; KYLIN, CWK Gleerups Forlag, Lund. (1956) 535–536.

Amansia jungermannioides MARTENS & HERING, *Flora* (1836) 481, figs. 1–4.

Polyzonia jungermannioides (Martens & Hering) J. AGARDH, Symb. (1841) 25.

Whole plant attached to other algæ (such as *Sargassum* or *Cystophyllum*) by a roughly circular disc about 156 micra in diameter, produced on its surculus which is subcylindric with a diameter of 161.2 micra. Thalli leaflike, broadly ovate or subrotund, only one cell thick, arranged in a slightly twisted manner, in some parts overlapping, the margins entire. Branches flattened, leaflike, up to 468 micra broad, 572 micra high. Plant pinkish-reddish. Mid-riblike structure present at median portion of branches, the apex mucronate.

AMANSIA sp. **Plate 8, figs. 92–94.**

Thallus in rosette form, arising from a subterete stem with a discoid attachment to the substratum. Fronds flat, brownish, 1 to 3 mm broad, 5 to 30 mm long, with numerous short lateral branches along the margin. Frond 2-layered, the cells 110 to 120 micra long, 23 to 34 micra broad. Blade flat, 98 micra thick. Pit connections are found on all sides of the cell; two on each end, one on each side. Tetrasporangia commonly found within the short lateral branches and arranged almost irregularly in two rows; spores cruciate, 3 micra broad.

Apex of short branchlets usually curved inward when sporangium is formed.

LAURENCIA CARTILAGINEA Yamada.

Laurencia cartilaginea YAMADA, Univ. Calif. Publ. Bot. (7) 16 (1931) 230–231, pl. 19, figs. a, o.

Thallus cartilaginous, cylindric, the axial branch 1 to 1.7 mm broad, ca. 15 cm high. Whole plant repeatedly pinnately branched, with a percurrent main axis; branches alternate, opposite, subverticillate; ultimate branchlets short, subcylindric, with a rounded or truncate apex. Cystocarps globular or urceolate, found at the end or lateral side of ultimate branchlets. Middle layer in the transverse section composed of ovoid cells 182 micra broad. Cell wall 18 to 26 micra thick. Outermost layer of cells elongated, arranged radially; directly below are slightly smaller oval cells, 1 to 2 layers thick.

LAURENCIA OBTUSA (Huds.) Lamouroux.

Laurencia obtusa LAMOUROUX in Yamada, Op. cit. (1931) 222–223, pl. 16, figs. a–c; pl. 17, figs. a–c.

Laurencia multiflora KÜTZING, Tab. Phyc. 15 (1865) 20, pl. 57 a–c.

Laurencia oophora KÜTZING, l. c. 15 (1865) 20, pl. 57, a–b.

Chondria obtusa C. AGARDH, Sp. Alg. 1 (1822) 340.

Plant ca. 17 cm high, attached by a short subterete stipe less than 1 mm long, more or less 1 mm diam., with an expanded discoid base. Primary branches pinnate, alternate, rarely dichotomous; ultimate branchlets short, apex rounded or truncate, with an open pit at the uppermost end. Branchlets alternate around entire axial length. Branching regular, commonly 5 mm apart; max. diam. of axis 2 mm. Plants found below low-tide level on rocks and sometimes on corals and shells.

LAURENCIA CEYLANICA J. Agardh.

Laurencia ceylanica J. AGARDH in Yamada, Op. cit. (1931) 244–245, pl. 30, fig. a; J. AGARDH, Epic. Florid. (1876).

Thallus prostrate on rocks, not more than 10 mm broad, compressed, irregularly dichotomous. Most striking characteristic of this species is presence of numerous small, knobby ultimate branchlets at the margins. Apices of branches usually rounded. Plant dark red. In life, plant membranaceous and highly gelatinous, toughening on drying.

LAURENCIA sp.

Thallus prostrate, cartilaginous, compressed; main axis branching dichotomously; ultimate branchlets short, knoblike when young, becoming tubular as length increases. Thallus relatively small, 2.5 cm high, 1 mm or less broad. Middle layer of thallus in transverse section consists of large oval cells up to 26 micra broad, becoming smaller toward periphery. Peripheral portion of oval cells which are about twice as long as broad, arranged side by side, 2 to 4 times larger than inner cells. Plant yellow-green to purple. Specimens found attached to shells, rocks, and sand particles by a discoid base, below low-tide level.

LAURENCIA JAPONICA Yamada (?).

Laurencia japonica YAMADA, Op. cit. (1931) 211–212, pl. 11, figs. a–b; fig. 1.

Thallus ca. 6 cm high, cylindric, cartilaginous, with a diameter of 1 mm or less; irregularly branched, branches at base few, at apex dense. Secondary branches alternate, pinnate on the main axis. Ultimate branchlets short, cylindric, more or less clavate; apices rounded or truncate. Cells which make up the thallus are in transverse section of subequal size, oval, 70 to 90 micra broad. Thallus dark green and reddish at apices. Specimens collected among cœlenterates in a dense coral bed, attached by a few basal rhizoids.

LAURENCIA sp.

Plant ca. 5 cm high, cartilaginous; thallus cylindric, less than 1 mm diam.; branches opposite, alternate, subverticillate, sometimes dichotomous, cylindric; mature ultimate branchlets cylindric or clavate, young ones globular; numerous proliferations found on main axis. Cystocarps present in pits of apices. Plant found below low-tide level, attached on rocks by short filamentous rhizoids. Thallus with numerous coralline crusts on its surface. Specimen reddish-brown.

LAURENCIA sp.

Thallus compressed or subcylindric membranaceous, 1 to 2 mm diam., 2 to 5 cm long. Plant prostrate on rocky substratum, attached by a cap-shaped structure connected to a short stipe, found on its ventral side. Branching dichotomous mostly, but alternate branching may also be found in the same plant. Specimens were collected below low tide level, tightly appressed on rocks.

Family CERAMIACEÆ

CHAMPIA sp.

Plant 4.5 cm high, subcylindric, main stem constricted regularly, with shorter alternate branches, these also constricted. Central stem and branches narrowed apically, ending in a blunt tip. Plant membranaceous. Thallus less than 1 mm diam. Intervals of constrictions about as long as broad.

BOTRYOCLADIA KUCKUCKII (Weber van Bosse) Yamada & Tanaka.

Botryocladia kukuckii YAMADA & TANAKA, Inst. Algol. Res., Fac. Sci., Hokkaido Imp. Univ. (i) **11** (1938) 77–78; BÖRGESEN, Det. Kgl. Vidensk. Selsk. Biol. Medd. (3) (1944) 23–26.

Chrysmenia kuckuckii WEBER VAN BOSSE, Siboga Exped. Monogr. **4** (1928) 466, fig. 199.

Plants of inflated vesicles, shortly pedicellate; 3 to 7 mm long, 2 to 5 mm broad; main axis and stipe subcylindric; attached to rocky substratum in exposed area by a discoid base. Specimen in transverse section reveals layers of cells of various forms, the larger ones forming the inner layer of the globular vesicle. Shapes (of cells) irregular mostly oval, 5 to 60 micra broad; thickness of transverse section 115 micra; cell wall to 12 micra thick. Specimens dark red.

Order RHODYMENIALES

Family RHODYMENIACEÆ

RHODYMENIA SPINULOSA Okamura.

Rhodymenia spinulosa OKAMURA, Icon. Jap. Alg. **7** (1933) 33, pl. 318, figs. 1–6.

Plant up to 2 to 4.5 cm high, attached to substratum by a compressed, cartilaginous, discoid base. Thallus irregularly dichotomous. Cystocarps elevated, globular, ca. 1 mm diam., borne on the surface of the thallus. Margins of thallus set with numerous tiny spines. Blade in transverse section 150 to 210 micra thick, made up of large colorless oval cells; at periphery are 1 to 2 layers of smaller cells. Plant purple-violet; found abundant on intertidal neap ramps on an exposed shore.

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103. *Sphacelaria furcigera* Kütz. A fully developed propagulum still showing the apical cell.
104. A vegetative filament showing a young lateral branch.

PLATE 10

FIG. 105. *Sphacelaria furcigera* Kützing. A young propagulum.
106. Vegetative filament with a lateral branch.
107. A fully developed propagulum with the apical cell.
108. Vegetative filament showing the polystichous arrangement of cells.
109. *Padina sanctæ-crucis* Börgesen. Cross-section of the thallus showing hairs, × 312.
110. Cross-section taken at the middle portion of thallus, × 243.
111. Longitudinal section of thallus, × 294.
112. Habit sketch of thallus, × 0.34.
113. *Padina pavonia* Lamouroux. Cross-section of the middle portion of the thallus showing a gametangium, × 312.
114. Longitudinal section of the thallus, × 378.
115–116. Habit sketches of thalli, × 0.35.
117. (Lamouroux) Hauck (?). Magnified longitudinal sections of thalli, × 294.

PLATE 11

FIG. 118. *Padina pavonia* (Lamouroux) Hauck (?). Magnified longitudinal sections of thalli, × 303.
119. Habit sketch of specimen, × 0.35.
120. Cross-section of thallus, × 296.
121. *Dictyota* sp. Cross-section of blade, × 269.
122. *Sphacelaria tribuloides* Menegh. Vegetative filaments showing mode of branching, × 288.
123–124. Propagula showing two stages in development, × 281.
125. A vegetatives filament, × 327.

PLATE 12

FIG. 126. *Sphacelaria furcigera* Kützing. Vegetative filament with lateral branching, × 230.
127. A fully developed propagulum showing one of its side branches, × 285.
128. Drawing of a vegetative filament, × 30.
129. *Chnoospora implexa* J. Agardh. Cross-section of thallus, × 50.
130–131. Magnified drawings of part of the cross-section, × 375.
132. *Dictyota* sp. Surface view of apical portion of thallus, × 257.
133. *Dictyota cervicornis* Kützing. Cross-section of blade, × 383.
134. *Colpomenia sinuosa* (Roth) Derb. et Sol. Plurilocular sporangia, × 105.
135. *Zonaria variegata* (Lamouroux) Agardh. Surface view of thallus, dorsal end, × 309.
136. *Dictyota dichotoma* (Hudson) Lamouroux. Cross-section of blade at the midportion of the thallus, × 309.

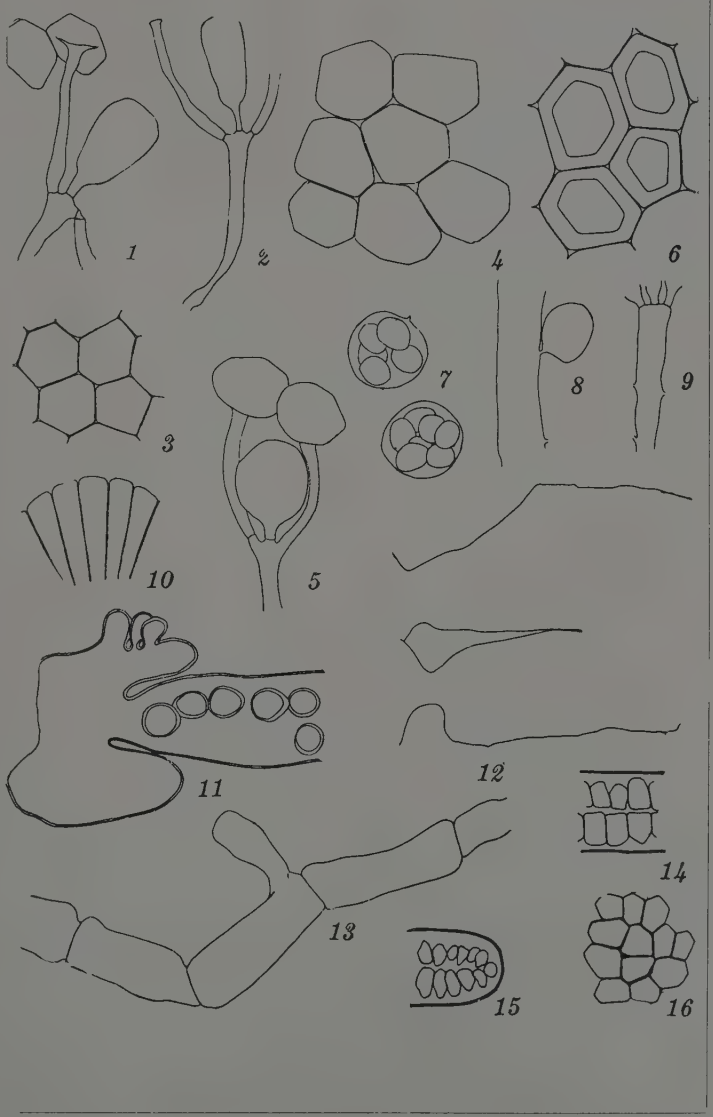
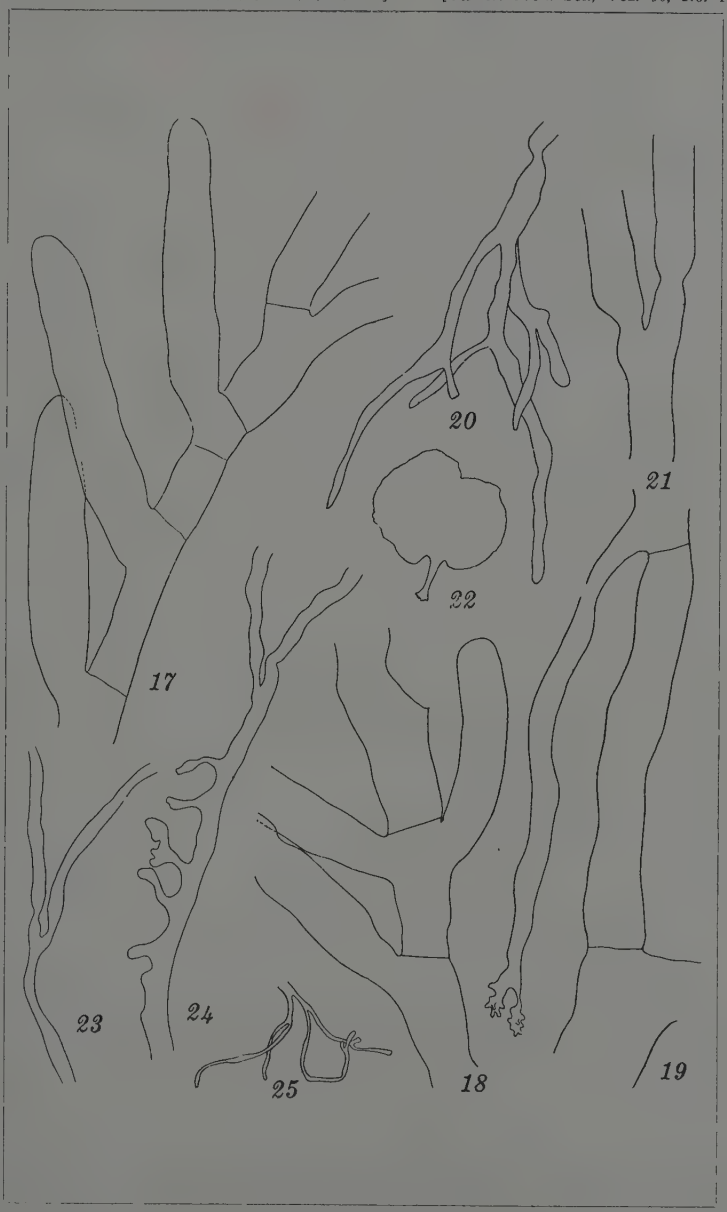


PLATE 1.



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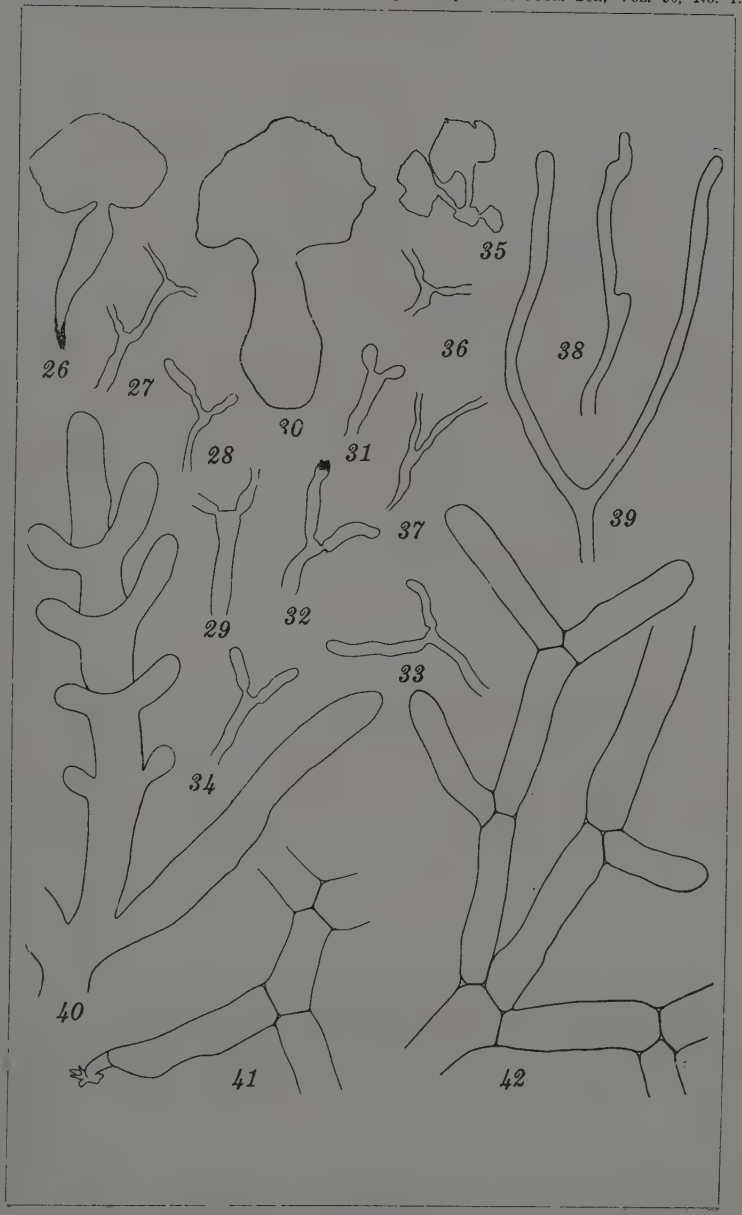

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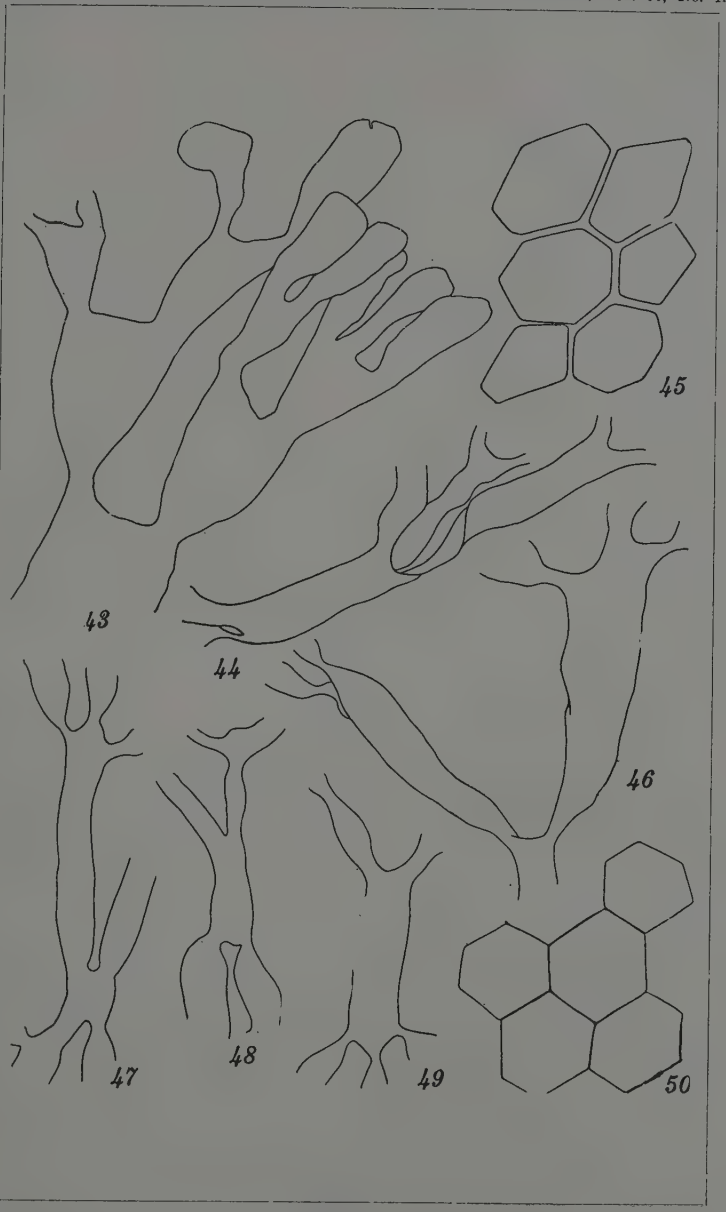

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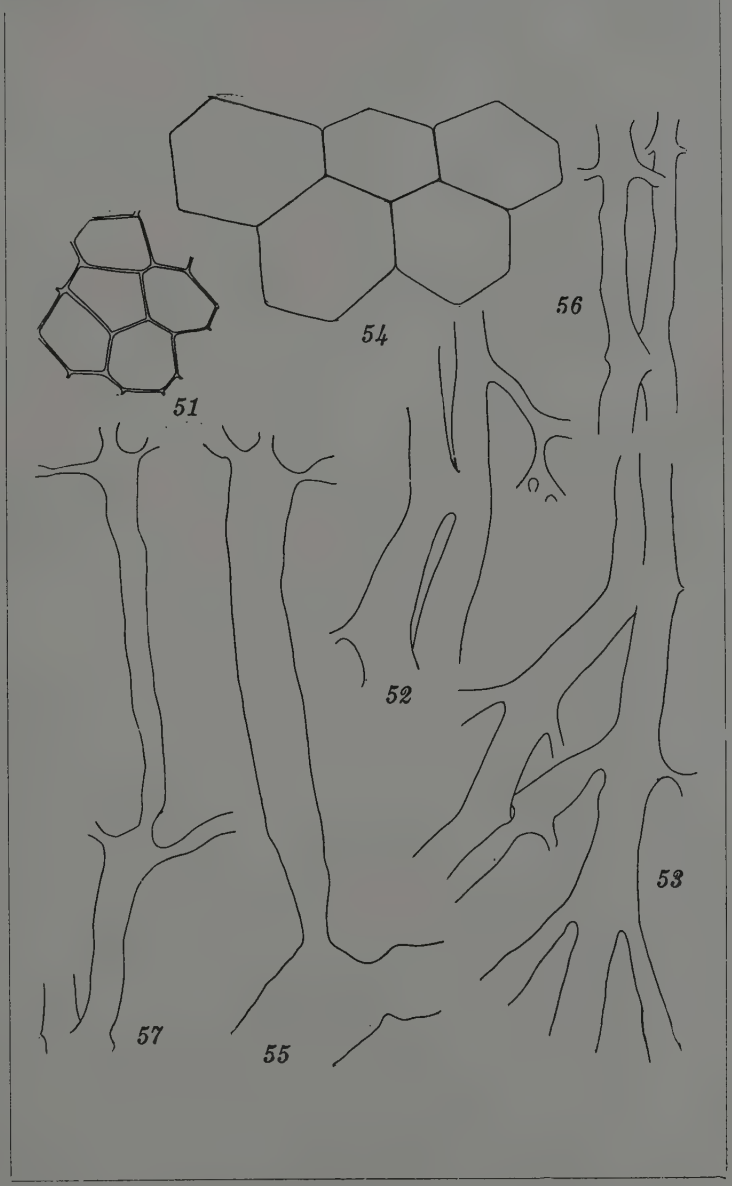

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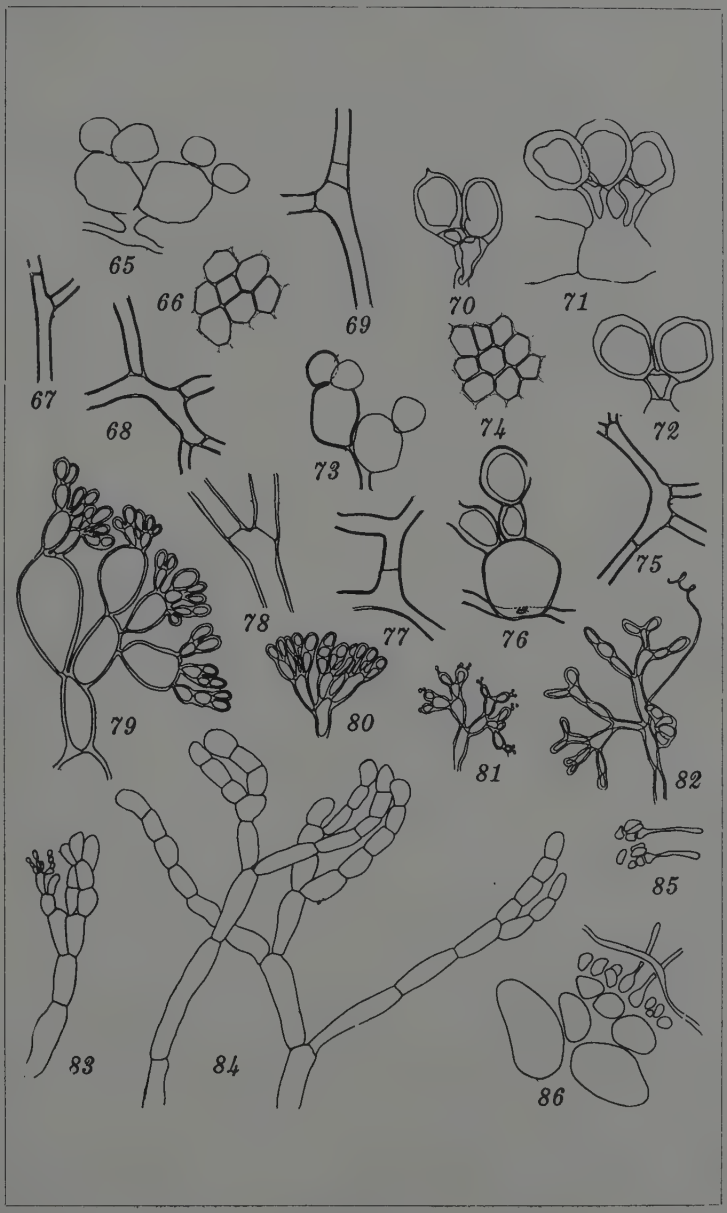

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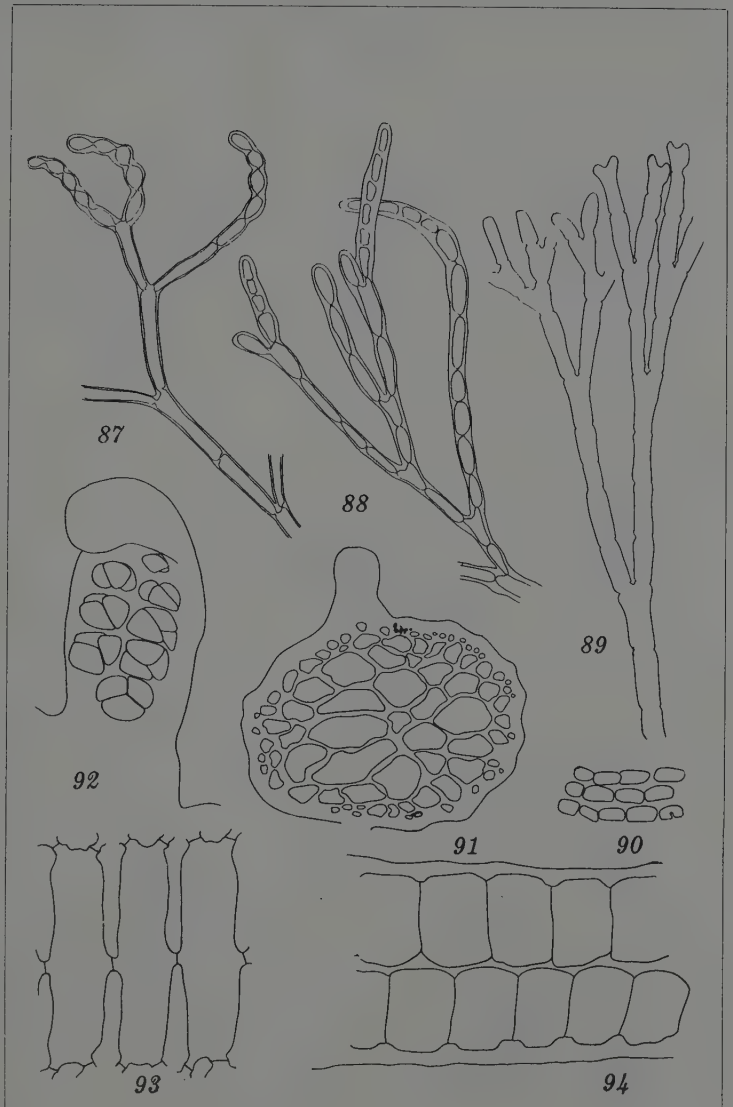

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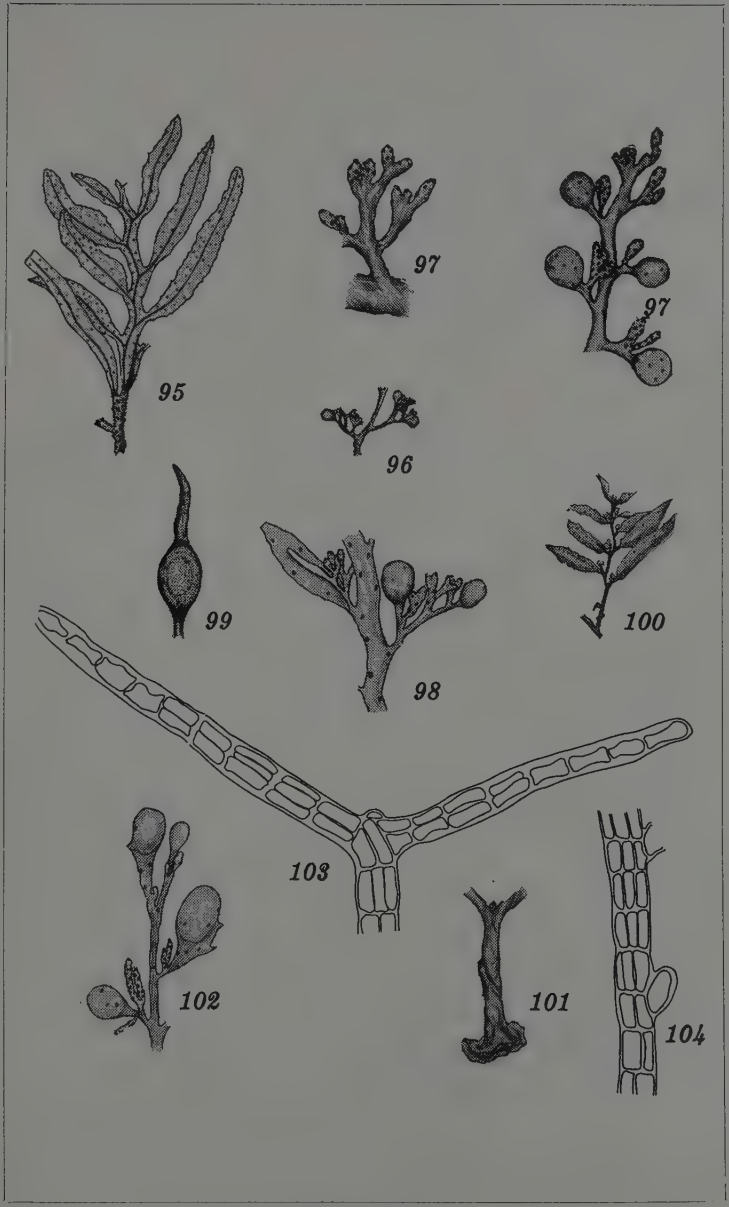

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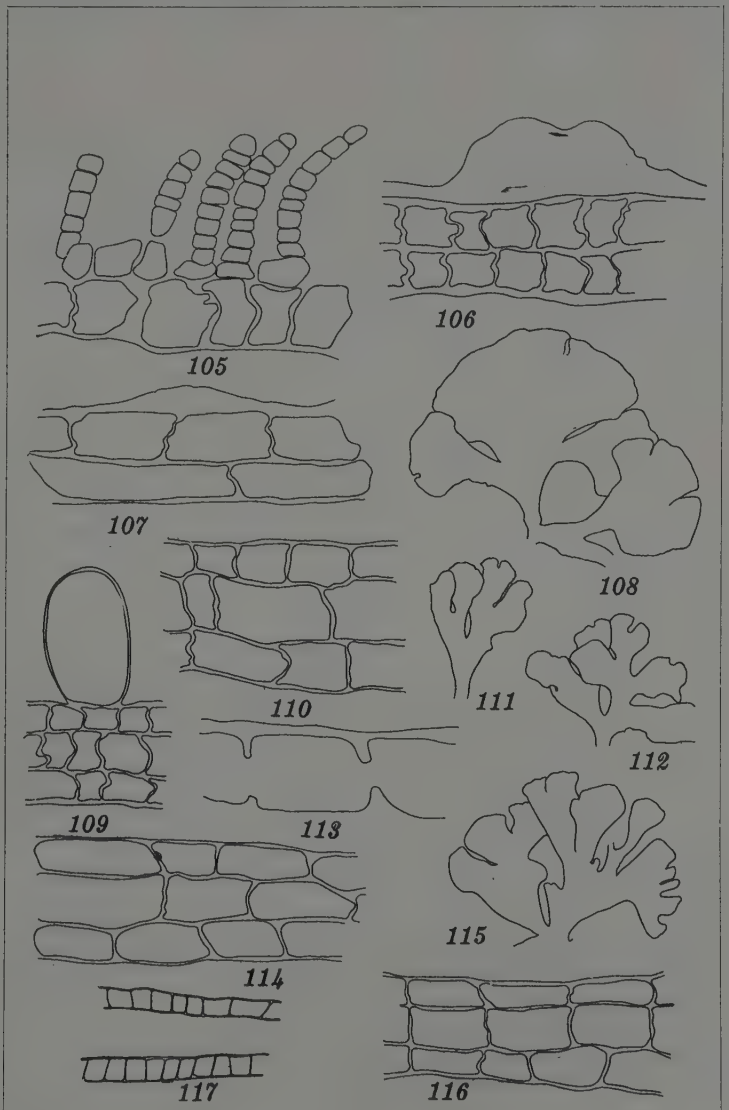

PLATE 10.

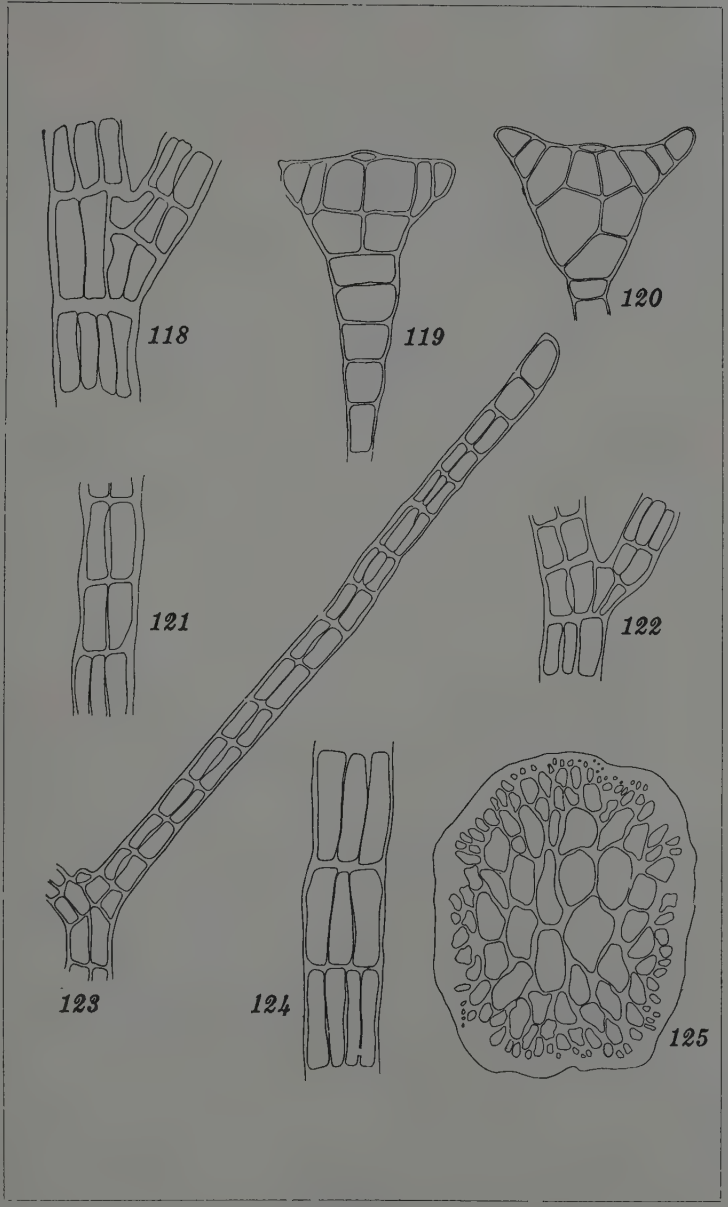

PLATE 11.

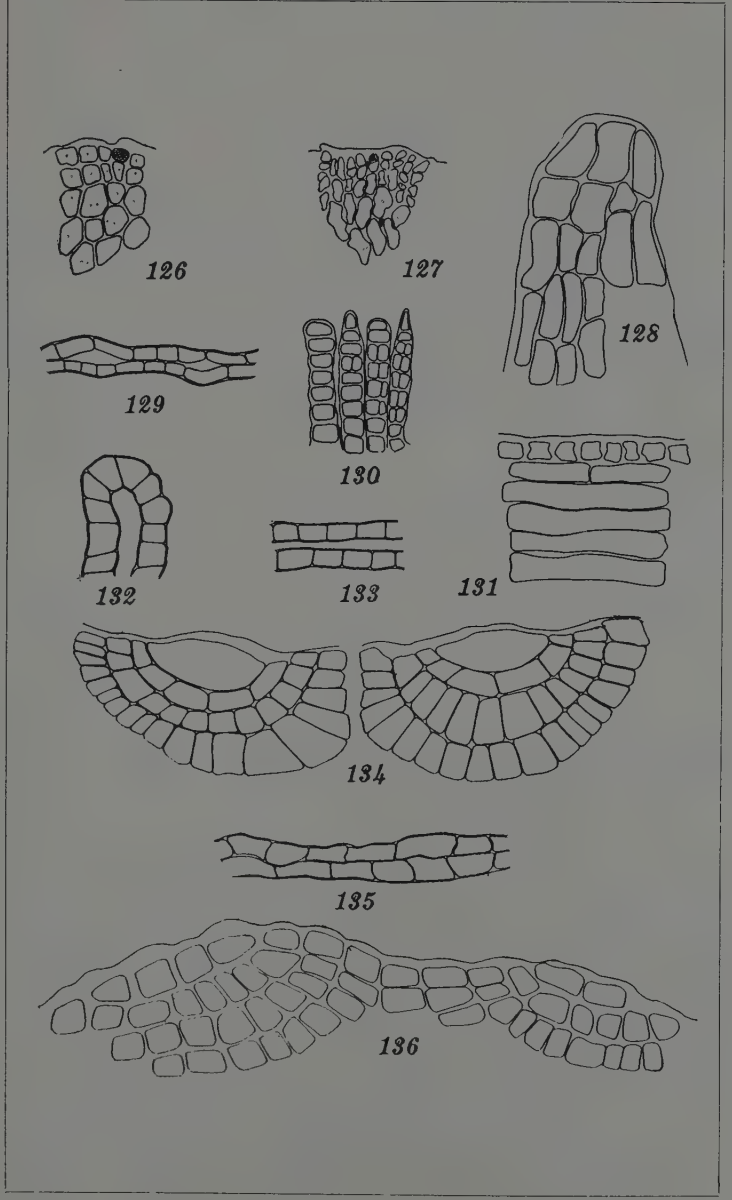

PLATE 12.

FAUNA OF THE PHILIPPINES, IX*

By Karl E. Schedl
Lienz, Austria

During the preparation of a checklist of the Scolytidæ and Platypodidæ of the Philippines it became necessary to re-examine a good number of specimens determined a long time ago. In the course of this work some new species have been found and also the second undescribed sexes of some known Scolytidæ and Platypodidæ. A great number of new records gained during the determination of several small collections will be included in the checklist mentioned above.

DECTYLIPALPUS NIGER sp. nov.

Male.—Nearly black, 8.5 mm long, not quite twice as long as wide. Compared with the well known *Dactylipalpus transversus* Chap. the new species is more densely and finely sculptured, the front shows a feeble but distinct longitudinal depression, the apical margin of the pronotum is more trapezoid in outline, the elytral striæ narrow but distinct, the interstices very densely granulate-punctate, the density of the punctures corresponding at least a fourfold row.

Front rather long, feebly depressed from the vertex to the anterior margin, below the center with a short longitudinal carina, surface very densely and rugosely punctured, the punctures bearing extremely short inclined scalelike hairs.

Pronotum much wider than long (35:15), widest at the base, base bisinuate, postero-lateral angles enclosing an angle of slightly more than 90 degrees and feebly rounded, sides nearly straight and feebly constricted up to the well defined antero-lateral angles, anterior margin on each side of the antero-lateral angles for a short distance transverse, thence separately and broadly rounded thus giving the impression of a trapezoid outline; disc similarly shaped as in *Dactylipalpus transversus* Chap. but covered by an extreme sculpture consisting of granulate punctures from which arise very short inclined scalelike hairs of a pale yellowish color.

* Contribution to the morphology and taxonomy of the Scolytoidea.

Elytra feebly wider (37:35) and more than twice as long as the pronotum, sides subparallel in the basal two fifths, thence gradually incurved to the rather broadly rounded apex, declivity commencing a short distance behind the middle, moderate strongly and obliquely convex; the striæ very narrow on the entire surface and of varying depth, the strial punctures not clearly defined, interstices very wide and with the same type of sculpture and pubescence as on the pronotum.

Holotype in Schedl collection.

Locality.—LUZON, Laguna, Mt. Makiling, elevation 2,000 ft., June 11, 1932, F. C. Hadden Coll.

The single specimen had been among a good series of true *Dactylipalpus transversus* Chap. and had been regarded as a variety of this species.

XYLECHINUS FORMOSANUS Schedl, fem. nov.

The original description in Philip. Jour. Sci. **57** (1935) 479 applies to the male, the female is of the same size, proportions and sculpture but the front is aplanate to feebly impressed, densely and finely punctured and the punctures bearing long semi-inclined scalelike hairs directed upwards and towards the median line.

LUZON: a single specimen in Schedl collection originates from Laguna, Mt. Makiling, elevation 2,000 ft., June 11, 1932, F. C. Hadden Coll.

DRYOCOETES SCHULTZEI sp. nov.

Piceous black, 2.7 mm long, 2.4 times as long as wide. Allied to *Dryocoetes coffeæ* Egg. but more slender, the pronotum more uniformly convex, the elytra more finely sculptured, etc.

Front convex, rather shining, finely punctured, with sparsely placed long and erect hairs of a pale yellowish color.

Pronotum about as long as wide, widest near the base, postero-lateral angles broadly rounded, sides subparallel to feebly arcuate on the basal half, apex broadly rounded, antero-lateral angles merely indicated; disc uniformly convex, with a very slight depression on each side of the median line in the basal third, moderate densely covered with small asperities, these

reduced in size towards the base, pubescence erect and moderately long. Scutellum shining, impunctate.

Elytra feebly wider and 1.7 times as long as the pronotum, widest at the commencement of the declivity, sides straight and subparallel up to the middle, apex broadly rounded, feebly angulate near the suture, declivity commencing well behind the middle, obliquely convex; disc with rows of medium-sized shallow punctures in hardly impressed lines, the interstices rather wide, irregularly and finely reticulate, each interstices with a median somewhat irregular row of finer punctures bearing short erect setæ; declivity with the impressed striæ more distinct, the suture very feebly elevated, some of the interstitial punctures by minute granules, pubescence longer than on the disc.

Holotype and paratypes in Schedl collection.

Locality.—LUZON, Isabela, San Mariano; Tayabas Province; Casiguran, all ex Schultzei collection.

All specimens have been marked by the late Forstrat Eggers in 1927 as *Thamnurgides schultzei* sp. nov. but a description never had been published.

POECILIPS INCOGNITUS sp. nov.

Yellowish brown (not quite mature), 2.4 mm long, 2.25 times as long as wide. Allied to *Pœcilips myristicæ* Roepke but less cylindrical in shape, the pronotum more feebly convex, the elytral striæ more distinctly impressed, the strial punctures larger, the declivity more gradually convex, etc.

Front entirely covered by the pronotum.

Pronotum feebly longer than wide (30:29), widest short behind the middle, postero-lateral angles rather strongly rounded, sides feebly divergent in the basal third, thence obliquely incurved to the moderate broadly rounded apex; disc less strongly convex as in *Poecilips myristicæ* Roepke, subshining, covered with very small low asperities, becoming reduced in size towards the base, pubescence very long, erect and sparsely placed. Scutellum triangular, shining, impunctate.

Elytra feebly wider (31:29) and 1.3 times as long as the pronotum, sides parallel up to the middle, apex very broadly rounded, declivity commencing in the middle and uniformly

convex; disc striate-punctate, the strial punctures rather largest and closely placed, the striæ feebly but distinctly impressed, the interstices wide, each interstice with a median irregular row of punctures being but little smaller than those of the striæ, these punctures bearing medium long erect setæ; on the declivity the striæ much more impressed, the strial punctures coarser, the punctures of the interstices replaced by small setose granules.

Holotype in Schedl collection.

Locality.—LUZON, Tayabas Cabibihan, September 1, 1930, Dipterocarpus vernicifluns, Ranau (Panao).

Up to date this species has been among the series of *Poecilips curtus* Egg.—P. *myristicæ* Roepke but after having seen many hundreds of this species from Ceylon it is evident that we have to deal with another species.

POECILIPS MYRISTICAE Roepke, masc. nov.

Male.—Yellowish brown, 2.0 mm long, 1.9 times as long as wide. Compared with the female the male has the pronotum more trapezoid in outline, widest at the base, much less convex, the small asperities restricted to the anterior third, rest of the surface densely punctulate. The elytral disc distinctly shorter, the declivity longer and more oblique, the striæ and strial punctures of the entire elytra less regularly placed and not so well defined as in the male.

Allotype and some parallotypes in Schedl collection.

Locality.—LUZON, Manila, W. Schultze.

XYLEBORUS DOSSUARIUS Eggers, masc. nov.

Male.—Body yellowish brown, strongly depressed in all six specimens, 1.4 to 1.8 mm long, 1.7 times as long as wide.

Front entirely covered by the beaklike extension of the pronotum; when seen from in front rectangular in outline, feebly convex, rather shining, covered by a very minute punctulate sculpture, a few small punctures toward the antero-lateral angles.

Pronotum wider than long, widest near the base, postero-lateral angles strongly rounded, sides feebly arcuate on to the basal two fifths, thence rather strongly incurved to a short

blunt beaklike extension, surface in all six specimens very feebly convex, strongly depressed (probably caused by the drying of the immature specimens) especially along the median line, finely and densely punctured on the sides and near the apex, the punctures bearing rather long inclined hairs directed obliquely towards the median line, the latter and a broader median space behind polished and impunctate. Scutellum triangular, shining and impunctate.

Elytra somewhat narrower and 1.3 times as long as the pronotum, short oval in outline, apex broadly rounded, flattened and wrinkled during the drying process so that the original shape has entirely disappeared, indications of striæ and strial punctures, which are rather coarse, visible.

Types in Schedl collection.

Locality.—LUZON, Rizal, Mt. Irid, W. Schultze; Rizal, Mt. Tucoluanbanoy.

XYLEBORUS PUSILLUS sp. nov.

Female.—Yellowish brown, elytra sometimes darker, 1.5 mm long, 1.8 times as long as wide. Eggers named provisionally two series of beetles from the Philippines in 1927 as *Xyleborus pusillus* sp. nov. but never published the description of them probably because of the close relationship of this species with *Xyleborus luzonicus* Eggers on one side and with *Xyleborus morstatt* Hag. on the other. Some specimens of this doubtful species bearing Forstrat Eggers handwritten identification labels I have received a long time ago but left them untouched until the present revision of the Philippine fauna. These specimens are too large, too stout and not enough cylindrical to be placed among *Xyleborus morstatti* Hag. on one side and have the elytral declivity gradually convex from the base to the apex a character not typical for *Xyleborus morigerus* Blandf. and *X. luzonicus* Egg. For the moment it seems to be advisable to regard these specimens as representatives of a new species.

Front plano-convex, shining, irregularly punctured and sparsely hairy, with indications of a low median carina.

Pronotum wider than long (24:20), similar to that of *Xyleborus morigerus* Blandf., widest at the beginning of the basal two fifths, postero-lateral angles rectangular and feebly

rounded, sides feebly arcuate in the basal two fifths, broadly rounded at the apex, the apical margin armed with a series of about eight subequal small asperities in the middle thus giving the impression of a short median extension; summit rather high and situated short behind the center of the pronotum, anterior area steeply convex and covered with densely placed small asperities, basal area very shining, very finely and rather sparsely punctured, pubescence short and erect all over. Scutellum of medium size, shining, impunctate.

Elytra feebly wider (25:24) and 1.3 times as long as the pronotum, sides subparallel up to the middle, apex very broadly rounded, declivity commencing short behind the base and very gradually convex; striate-punctate, the striæ indistinct near the base, more clearly defined on the declivital convexity, the strial punctures smaller anteriorly larger and more impressed behind, the interstices wide, each one with a median row of small setose punctures very similar as in *Xyleborus morigerus* Blandf.

The male is very similar as that of *Xyleborus morigerus* Blandf., but little larger, 1.2 to 1.3 mm long, the pronotum more trapezoid in outline, with a shallow median emargination on the narrowly rounded apical margin, disc less uniformly convex, with a shallowly depressed longitudinal furrow from the anterior emargination up to the center fading out behind, indistinctly punctured behind, very finely asperate in front, pubescence erect and of moderate length. Elytra short oval in outline, exactly as in the male of *X. morigerus* Blandf., convex, densely and coarsely punctured in fairly regular rows, the rather long hairs arising from the interstitial punctures only.

Holotype, allotype, and paratypes in Schedl collection.

Locality.—LUZON, Rizal, Mt. Irid, W. Schultze; LUZON, Rizal, Mt. Tucoluanbanoy.

XYLEBORUS TRUNCATIPENNIS sp. nov.

Female.—Reddish brown, 1.3 mm long, 2.8 times as long as wide. More closely allied to *Xyleborus longior* Egg. but much smaller, the pronotum stouter, the elytra more slender, the elytral declivity opaque, very finely rugose and with numerous small granules all around its truncate shape.

Front broadly convex, subshining, minutely punctulate and roughly punctured, pubescence very short, erect, inconspicuous.

Pronotum feebly longer than wide (1614), postero-lateral angles rectangular and feebly rounded, sides subparallel on the basal two fifths, anterior margin moderate broadly rounded, a subapical constriction feebly indicated; summit in the middle, moderate in height, anterior area obliquely convex and densely covered with very small asperities, basal area subshining, minutely punctulate, the secondary punctuation moderate in size, the punctures not closely placed, pubescence short, restricted to the apex and the sides. Scuttellum not visible.

Elytra as wide and 1.4 times as long as the pronotum, sides subparallel on the basal four fifths, broadly rounded at the apex, declivity short, obliquely truncate, disc subshining, very finely reticulate, striæ and strial punctures indistinct, the minute uniseriately placed punctures of the interstices partly indicated by very short scalelike hairs; declivity oblique, the suture indistinctly raised, the apical and lower side margins rather acute, the upper limitation not so sharply defined, all around the margin with numerous minute and pointed granules, declivital face finely rugose and with very short inconspicuous pubescence.

Holotype and three paratypes in Schedl collection.

Locality.—Balbalan, Philippines, leg. Bottcher.

Another species with an in literis name *Xyleborus pusillus* Egg. but so far without description.

XYLEBORUS CONCISUS Blandf., masc. nov.

Mr. F. G. Browne has placed *Xyleborus marginatus* Egg. in synonymy to *X. Concisus* Blandf. [Sarawak Mus. Journ. (5) **6** (1955) 354] and Mr. L. G. E. Kalshoven, Tijdsch. v. Ent. **102** (1959) 146, did the same with *Xyleborus sordicaudulus* Egg. female. The male of this latter species has been examined once more and it seems it has to be referred to *Xyleborus interjectus* Blandf. The description of the true male of *Xyleborus concisus* Blandf. is given below.

Male.—Yellowish, all specimens immature, 1.36 to 1.56 mm long, twice as long as wide.

Front entirely covered by the pronotum when viewed from above, rather small, nearly flat, shining, finely and sparsely punctured when seen from in front, with a series of long hairs along the epistomal margin.

Pronotum about as wide as long, postero-lateral angles very strongly rounded, sides subparallel on the basal third, thence gradually incurved to the rather broadly rounded apex, apical margin with a minute notchlike emargination in the middle; disc nearly flat, very feebly convex, shining, somewhat indistinctly punctured and with a short erect pubescence. Scutellum very small, triangular and shining.

Elytra much wider (23.0:18.5) and 1.7 times as long as the pronotum, humeral angles broadly rounded, sides parallel on the basal third, thence gradually incurved, apex broadly rounded, uniformly convex from the base to the apex, somewhat flattened in the apical third; disc finely striate-punctate, the interstices reticulate-rugose, indistinctly punctured, each one with a median row of semierect long yellowish hairs in the basal third of the elytra, this long pubescence extending farther behind on the sides, on the dorsal part the hairs replaced by small inclined pale scales very similar as in the female; apical margin well defined but not acute.

Allotype and parallotypes in Schedl collection.

Locality.—Java, G. Slamet, April 9 and July 19, 1930, ex pohon soerian [Toona (Cadrella) sinensis Roem], F. C. Drescher Coll.

XYLEBORUS PARVUS Lea.

Many years ago I determined a female specimen from Queensland, Australia as *Xyleborus parvus* Lea but leaving it under this name with a question mark. Late Forstrat Eggers on the other hand labelled a series of females from Mt. Irid. Luzon in 1931 as *Xyleborus subagnatus* sp. nov. without publishing a description of this species. These two series and a single specimen from Bougainville Isl., Kietta, October 16, 1937, J. L. Froggatt are exactly the same. As the original description of Lea is rather brief it seems advisable to publish a more exact diagnosis. In case that the type of *Xyleborus* (*Xylopertha*) *parvus* Lea can be found and the description given below does not apply to it, it will be easy to give these specimens another name.

Female.—Reddish brown when mature, 2.3 to 2.5 mm long, 2.6 times as long as wide.

Front broadly convex, minutely punctulate, finely punctured, the punctures giving rise to long erect hairs.

Pronotum longer than wide (34:28), postero-lateral angles rectangular and somewhat rounded, sides parallel on the basal two fifths, apex broadly rounded; summit in the center of the pronotum, moderate in height, anterior area convex and very finely and densely asperate, basal area more shining and finely punctured, pubescence erect, fine, longer anteriorly and on the sides. Scutellum rather small, finely punctured.

Elytra as wide and 1.2 times as long as the pronotum, cylindrical, sides parallel on the basal three fifths, apex very broadly rounded, declivity rather short, steeply convex; disc with rows of shallow rather small punctures in hardly impressed striæ, the interstices fairly wide, each one with a not quite regular row of fine punctures bearing semierect moderately long hairs rather conspicuous towards and on the declivity, the latter subopaque, opalescent shining as in *Ips typographus* L. or *Xyleborus mascarensis* Eichh., the striæ more distinctly impressed, the strial punctures larger and more closely placed, the punctuation of the interstices similar as on the disc, the first interstice with three to four pointed granules on the upper half, widened below and with a larger tubercle on the lower half, the second interstice with a few very small granules at the commencement of the declivity and a pointed tubercle at the apical margin, similar tubercles also at the extremity of the interstices three and five, the third bearing two to three larger tubercles on the declivital face, smaller granules on the other interstices above and on the sides.

PLATYPUS LUNIFER Schedl, fem. nov.

Female.—Reddish brown, 3.9 mm long, 3.45 times as long as wide.

Front shallowly concave from eye to eye, surface minutely punctulate, sparsely punctured, the punctures bearing erect hairs.

Pronotum longer than wide (33:30), femoral emarginations rather deep, surface shining, finely and sparsely punctured, median sulcus moderate in length, surrounded by broadly cordiform patch of very densely placed punctures.

Elytra feebly wider (32:30) and twice as long as the pronotum, sides straight on the basal three fifths, apex broadly rounded, subtransverse near the suture, when seen from above, broadly angulate when inspected from behind, declivity restricted to the apical fourth and feebly convex; disc shining, with rows of very fine partly submerged punctures in hardly impressed lines except near the base where they are distinctly so, interstices wide, with some minute, partly indistinct punctures, base of the third somewhat widened and finely asperate; declivity finely rugosely punctured and with short semierect pubescence.

Allotype in Schedl collection. Some more specimens probably under the name of *Crossotarsus emarginatus* Schedl in the Museo Civico in Genova.

Locality.—Mentawei, Sipora, Sereinu, V. VI. 94, Modigliani.

PLATYPUS QUADRIFISSILIS Schedl, fem. nov.

Female.—Reddish brown, 2.8 mm long, 4.2 times as long as wide.

Front plano-convex, coarsely and densely punctured, with short semierect pubescence, and a short median sulcus.

Pronotum much longer than wide (27:19), widest behind the rather deep femoral emarginations, surface shining, with a very long median sulcus, surrounded by a long oval patch of densely placed punctures, remaining punctuation rather sparse, very fine in the basal half, a little coarser towards the apex.

Elytra hardly wider (20:19) and 1.7 times as long as the pronotum, sides straight throughout, very feebly constricted short before the subtransverse apex (when seen from above), declivity perpendicular; disc shining, lineate-punctate, first striæ narrowly impressed, all striæ more strongly impressed short before the declivity; declivital face subopaque, densely punctulate, with a short erect pubescence, the lateral processes of the male indicated by short pointed angles at the sides, the two median lobes by the downward extended bisinuate apical margin.

Allotype in Schedl collection.

Locality.—Malaya, Selangor, Buloh Forest Reserve, November 16, 1925. Some more specimens certainly in the British Museum.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XLVIII

By Charles P. Alexander
Amherst, Massachusetts

FOUR PLATES

In this paper I am continuing the discussion of species of crane-flies taken in the Himalayas of northern India by Dr. Fernand Schmid. The species described belong to the subfamily Tipulinæ and virtually all to the genus *Tipula* Linnæus which is strikingly developed throughout mountainous eastern and central Asia. I am very deeply indebted to Dr. Schmid for his continued interest in collecting these flies, the types of which are preserved in my personal collection.

TIPULINÆ

CTENACROSCELIS PEROBTUSUS sp. nov. **Plate 1, fig. 11.**

Male.—Length, about 33 millimeters; wing, 37; antenna, about 4.

Female.—Length, about 36 to 37 millimeters; wing, 34.5 to 36; antenna, about 4.

Allied to *Ctenacroscelis majesticus* (Brunetti), C. *dorsopleuralis* Alexander, and *C. dorsopleuralis surya* Alexander, differing from all especially in the structure of the male hypopygium.

Darkened pleural stripe narrow but clearly evident, lacking in *majesticus;* broadest on propleura, extending across the extreme dorsal pleurites to the wing root. Mesonotal præscutum with a conspicuous orange area before the suture, as in *majesticus.* Wings with the ground darker than in *majesticus,* the obliterative area before the stigma distinct. Male hypopygium (Plate 1, fig. 11) with the lobes of the tergite, *t,* very narrowly obtuse at tips, each densely covered with black setæ that extend almost to the apex of lobe, central area and margin with very short setulæ, emargination broad; no lateral hair brushes, as in *dorsopleuralis.* Outer dististyle, *d,* very broad, its apex unusually obtuse, not truncated; greatest width on basal half,

approximately two-thirds the length; setæ chiefly on basal half, the discal ones stout, outer setæ small and sparse. Inner dististyle with the basal enlargement low and obtuse, with few setæ; some distance back from tip on lower margin with a conspicuous dilation; apex produced ventrad into a sclerotized spine. Eighth sternite, *8s*, with the lobes low and obtuse, setæ very abundant, of moderate length only, when compared with *dorsopleuralis surya;* setal areas continued cephalad from the lobes onto the main body of sternite.

I have a homotype of *majesticus* that was compared with the type of *majesticus* by Edwards (Shillong, Assam). The hypopygium differs from that of the present fly in the following regards. Tergal lobes broadly obtuse at tips, the emargination narrowly U-shaped. Outer dististyle longer and narrower in proportion to its width, the length exceeding twice the diameter. Inner dististyle distinct, beyond midlength gradually dilated, thence narrowed to the blunt unarmed tip, with no marginal expansion. Central area of eighth sternite produced, very shallowly emarginate, forming two small lobes that bear relatively few long setæ.

Habitat.—Sikkim.

Holotype, male, Chongpung, altitude 4,920 feet, September 27, 1959 (*Schmid*). Allotype, female, Manu, altitude 4,920 feet, May 10, 1959 (*Schmid*). Paratype, female, Lingdok, altitude 4,600 feet, May 7, 1959 (Schmid).

CTENACROSCELIS NIRVANA sp. nov. **Plate 1, fig. 12.**

Belongs to the *albovittatus* group; antennæ orange, terminal segment black; mesonotal præscutum with four brownish gray stripes that are narrowly bordered by darker; pleura brownish yellow with a dark brown dorsal stripe; femora yellow, tips broadly blackened, tarsi black, terminal segment orange, claws bidentate; wings weakly infuscated, restrictedly patterned with still darker areas; male hypopygium with the tergite long, posterior border broadly emarginate, lateral lobes narrow, with short setæ; outer dististyle expanded distally, the outer edge emarginate to the style appears shallowly forked; inner dististyle complex in structure, provided with outer points and blades; eighth sternite broad, with a triangular central setiferous area.

Male.—Length, about 21 millimeters; wing, 25; antenna, about 3.1.

Frontal prolongation of head elongate, dark brown, narrowly paler at base; nasus blackened, slender, with few setæ; palpi brownish black, second segment slightly paler. Antennæ with scape and pedicel pale yellow, remainder more orange-yellow, terminal segment abruptly black; flagellar segments subcylindrical, the verticils unusually small, on the more proximal segments scarcely one-fourth the length of the segment, a short dense pale pubescence additional to the verticils. Head dark brown, front and very narrow orbits obscure yellow; narrowest part of anterior vertex and sides of occipital area restrictedly darker; vertical tubercle far cephalad, tumid, narrowly impressed medially.

Cervical region pale yellow above, black on sides. Pronotum dark brown. Mesonotal præscutum with the interspaces obscure orange, disk with four brownish gray stripes that are narrowly bordered by darker brown, humeral region medium brown, lateral borders paler; scutum light brown, each lobe with two brownish gray areas that are narrowly bordered by brown, separated in front by a triangular yellow, somewhat as in *fumipennis;* scutellum brown, with long yellow setæ, narrowly yellowed on the delimited posterior border; mediotergite brownish gray, posterior third and lateral borders more ochreous; pleurotergite brownish yellow, katapleurotergite with long yellow setæ. Pleura brownish yellow, with a narrow but conspicuous dark brown longitudinal stripe, broadest on cervical region, narrowed posteriorly, ending opposite the origin of the wings, the adjoining dorsopleural membrane conspicuously light yellow, becoming darker above; meron yellow, banded with pale brown. Halteres dark brown, base of stem not brightened. Legs with coxæ pale brown basally, the tips broadly pale yellow, all with long pale setæ; trochanters obscure yellow; femora yellow, tips broadly blackened; tibiæ light yellow, tips narrowly darkened; tarsi orange, outer segments passing into black, terminal segment orange; claws bidentate, including an acute basal spine and a broad obtuse tooth at near midlength. Wings weakly darkened, paler at tip and on posterior half; prearcular and costal regions darker; stigma brown; restrictedly darkened seams on m-cu, outer end of cell 1st M_2 and adjoining veins and on 1st A; veins brownish yellow, darker in the patterned parts.

Veins unusually glabrous, trichia lacking on virtually all veins expecting C and outer parts of R and R_1. Venation: Both R_{1+2} and R_3 strongly upcurved, especially the distal third of the latter; petiole of cell M_1 about one-half longer than m; m-cu long, gently sinuous, before one-third the length of M_{3+4}.

Abdominal tergites medium brown, unpatterned; basal sternites more yellowed, vaguely patterned with pale brown; outer segments darkened. Male hypopygium (Plate 1, fig. 12) with the tergite, *t*, elongate, posterior border broadly emarginate, produced into long narrow lateral lobes, provided with short setæ, the border with very dense microscopic setulæ; center of disk back from the border more or less tumid. Outer dististyle, *d*, pale, expanded outwardly, the lower margin sclerotized, terminating in a short point, the upper angle rounded, the apex conspicuously emarginate to appear shallowly forked; setæ small and sparse. Inner dististyle very irregular in form, as shown; outer half with the beak bilobed, the upper lobe stouter; outer crest with a triangular flattened blade. Gonapophysis appearing as an oval glabrous dark-colored blade. Eighth sternite, 8s, broad, widened outwardly; central area of posterior border fringed with yellow setæ; central part of sternite with a large triangular area of similar setæ, the point of the area directed backward, not quite reaching midlength of the segment. Eighth tergite transverse, the outer lateral parts with very abundant delicate setæ; median area with a restricted group of longer hairs.

Habitat.—Sikkim.

Holotype, male, Teng, altitude 4,600 feet, May 12, 1959 (*Schmid*).

The most similar described species is *Ctenacroscelis fumipennis* (Brunetti), the hypopygium of which has equally but quite different complex inner dististyles. The emarginate tergite and outer dististyle of the present fly provided strong specific characters.

TIPULA (BELLARDINA) ARJUNOIDES sp. nov. **Plate 2, fig. 13.**

Generally similar to *arjuna;* male hypopygium with the tergal lobes low, densely setiferous; from base of median emargination of tergite arises a conspicuous furcula; outer dististyle including a flattened outer blade and two smaller lobes at near mid-

length, all variously fringed with setæ; inner style a flattened glabrous paddlelike blade.

Male.—Length, about 22 millimeters; wing, 23.

Frontal prolongation of head dark cinnamon brown, the outer dorsal part, with the nasus, blackened; palpi black (outer segments broken). Antennæ with scape and pedicel light yellow; flagellum broken. Head brownish gray, more buffy on the low vertical tubercle; sides of genæ and a narrow central line on posterior vertex dark brown.

Pronotum broadly dark brown, abruptly light yellow on sides. Mesonotum almost uniformly dark brown, the præscutum with four scarcely differentiated stripes that are narrowly bordered by still darker, the lateral borders slightly darker; scutal lobes similarly vaguely patterned with darker brown, scutellum and postnotum slightly more pruinose. Pleura dark brown, broadly light gray behind, including the dorsal sternopleurite, ventral pteropleurite, katapleurotergite, metapleura and dorsal meron; dorsopleural region broadly and very conspicuously light yellow. Halteres infuscated, base of stem and apex of knob obscure yellow. Legs with coxæ medium brown basally, buffy gray outwardly; trochanters buffy yellow, darkened apically beneath; femora yellow, tips abruptly black, narrow but very conspicuous; tibiæ yellow, tips more narrowly dark brown; tarsi obscure yellow, outwardly passing into dark brown; claws toothed. Wings light brown, restrictedly patterned with yellow areas, including prestigmal and poststigmal brightenings, the latter continued backward across the base of cell R_2 into cell R_3; yellow marginal areas in centers of cells R_3 through 1st A, the tips of the intervening veins darkened; basad of cord with yellow areas before origin of Rs, at near two-thirds cell M, crossing into cell Cu, and near the basal third of cells Cu and 1st A; slightly darker brown areas include the stigma, a small spot at origin of Rs, outer end of cell 1st M_2, and in cell M before and beyond the brightened area; veins yellow, including the darkened areas. Outer ends of veins beyond cord with small macrotrichia, sparse or lacking on proximal end of R_{4+5}; basad of cord trichia more sparse but extending basad almost to arculus, including a series on the prearcular anal vein. Venation: Cell M_1 deep, its petiole about one-third m; m-cu on M_4 shortly beyond the vertical basal section.

Abdomen reddish yellow basally, basal tergite and lateral borders of succeeding segments restrictedly darker brown, hypopygium yellow. Male hypopygium (Plate 2, fig. 13) with the tergite, *t*, transverse, posterior margin with a U-shaped notch, forming broad thickened lobes that are provided with abundant long setæ; from base of notch protrudes a conspicuous furcula. Outer dististyle, *d*, large, extended into a flattened blade, at near midlength with two smaller lobes or blades, all with strong setæ, basal part extended outwardly into a point or narrow blade. Inner dististyle slightly smaller, appearing as a flattened glabrous paddlelike blade, its tip obtuse, rectangularly bent beyond base; margin of proximal half with long yellow setæ, the outer ones smaller.

Habitat.—Pakistan.

Holotype, male, Surgun Sur, Northwest Frontier Province, altitude 6,875 feet, July 29, 1953 (*Schmid*).

Although generally similar to *Tipula* (*Bellardina*) *arjuna* Alexander, the present fly is quite distinct in the hypopygial structure, including especially the tergite and dististyles.

TIPULA (BELLARDINA) DYROPE sp. nov.

Size relatively large (wing of female 22 millimeters); mesonotal præscutum dark brown, with four paler stripes, the intermediate pair yellowed; wings strongly infuscated, especially beyond the cord, restrictedly patterned with pale yellow; veins beyond cord with abundant macrotrichia; petiole of cell M_1 long.

Female.—Length, about 19 millimeters; wing, 22; antenna, about 3.5.

Frontal prolongation of head long, slightly exceeding the remainder, brown throughout, without nasus; palpi with first and last segments black, intermediate ones brown, with pale incisures. Antennæ brownish black, pedicel yellow; basal enlargements of flagellar segments slightly developed; longest verticils exceeding the segments. Head with front and sides of vertical tubercle cinnamon brown, remainder of head much darker; vertical tubercle high, slightly emarginate at midlength.

Pronotal scutum dark brown, pale on sides, scutellum more yellowish brown. Mesonotal præscutum with ground dark brown, with four paler stripes, the intermediate pair more yellowed;

setæ of interspaces long and conspicuous; scutal lobes brown, central area more grayish brown; posterior sclerites of notum brownish gray, scutellum darkened on either side at base, mediotergite similarly darkened laterally; scutellum and mediotergite with very long pale setæ. Pleura chiefly dark brown; dorsopleural region buffy. Halteres with stem yellow, knob infuscated. Legs with coxæ dark brown, trochanters paler; remainder of legs yellowish brown, outer segments darker, tarsi black; tibial spurs long and slender. Wings strongly infuscated, especially beyond cord, very restrictedly patterned with pale yellow; prearcular and costal fields yellow; yellow areas include prestigmal and poststigmal brightenings, the latter barely indicated in cells R_3 and R_5; small clearly defined marginal spots in cells R_2 to M_4, largest in the radial cells; no subterminal brightenings in radial field; basad of cord with very restricted brightenings in cell M, two in cell Cu, and one in 1st A; a narrow yellow line in cell 2nd A adjoining the vein, but without other pale marks; conspicuous more whitened obliterative marks before stigma, outer end of cell R, and in cell 1st M_2; arculus restrictedly whitened; veins yellowish brown, more yellowed in the brightened fields. Veins beyond cord with abundant macrotrichia, lacking on bases of M_2 and M_4; basad of cord with trichia over the entire length of Sc, M and 1st A, lacking on most of Cu_2 and the restricted base of 2nd A; prearcular anal vein with trichia. Venation: Petiole of cell M_1 long, subequal to m; cell 1st M_2 short-pentagonal, m subtransverse; m-cu at fork of M_{3+4}.

Abdominal tergites reddish yellow, the lateral borders narrowly blackened; sternites more reddened, the posterior and lateral borders of the outer segments darkened. Ovipositor with cerci straight and relatively slender, tips subacute.

Habitat.—Sikkim.

Holotype, female, Yumtang, altitude 12,140 feet, June 27, 1959 (*Schmid*).

Tipula (*Bellardina*) *dryope* superficially is generally similar to *T.* (*B.*) *oenone* sp. nov., differing from this and other allied species in the greatly reduced yellow pattern of the wings. The trichiation of the wing veins of the present fly is quite different from that found in *oenone*.

TIPULA (BELLARDINA) LITHOSTROTA sp. nov. **Plate 2, fig. 14.**

Size medium (wing 21 millimeters); mesonotal præscutum buffy, patterned with gray and brown; nasus lacking; basal flagellar segments bicolored, the outer passing into black; wings with a tessellated yellow and light brown pattern; male hypopygium with the tergite terminating in two spinulose lobes, with further ventral armature; outer dististyle angularly bent at near midlength, with a conspicuous subtriangular lobe.

Male.—Length, about 20 millimeters; wing, 21; antenna, about 4.

Frontal prolongation of head light brown, darker basally above, without nasus; palpi light brown, terminal segment black. Antennæ with scape obscure yellow, above with four transverse impressions; pedicel clear light yellow; basal flagellar segments bicolored, dark brown to black on the relatively small basal enlargement, the outer end obscure yellow, the latter becoming more obscured outwardly, on the sixth or seventh segment passing into black; longest verticils about one-half longer than the segment. Head buffy, patterned with brown on central part of vertex, including the conspicuous entire tubercle; a small brown spot laterad of antennal fossa; posterior orbits broadly paler brown; sides of vertical tubercle somewhat clearer yellow.

Pronotum brown, patterned with buffy, the scutum with conspicuous black and yellow setæ. Mesonotal præscutum with the ground restrictedly buffy, disk with four stripes, including a greenish gray intermediate pair, the borders brown, confluent posteriorly; lateral stripes appearing almost uniformly brown because of the very broad margins, each stripe further encircled by a narrow yellow ring; lateral præscutal margins strongly darkened, humeral region less evidently so; interspaces with conspicuous erect setæ; scutal lobes greenish gray, each with two brown areas that are bordered internally by darker, central region darker brown posteriorly; scutellum gray, with a central brown vitta and sparse brown setigerous punctures, parascutella light brown; mediotergite buffy yellow, with a capillary brown central line and a more diffuse brown area on either side of anterior half; scutellum and mediotergite with conspicuous black setæ; pleurotergite yellowed to reddish brown, the elevated katapleurotergite more silvery pruinose. Pleura buffy brown, including the anterior dorsopleural region; a broad darker brown longitudinal stripe beginning on propleura, wid-

ened behind, more pruinose on the pteropleurite. Halteres yellow, base of knob weakly darkened. Legs with coxæ buffy yellow, freckled with abundant brown setigerous punctures; trochanters yellow; femora reddish yellow, tips narrowly brownish black; tibiæ slightly darker, the tips gradually passing into black; tarsi black; claws of male with a small tooth. Wings with the ground light yellow, costal region clearer yellow, unpatterned; a conspicuous light brown zigzag pattern, as in various allied species, before the cord with a central area before midlength of basal cells, bordered on either side by a subequal band of the ground color; darker brown areas at arculus, origin of Rs, cord and outer end of cell 1st M_2; stigma brownish yellow, inconspicuous; beyond cord with nearly the outer half of cell R_5 yellowed, all outer medial cells with a central yellow marginal spot, poststigmal pale area relatively extensive; veins brown, Sc, R and both branches of Cu more yellowed. Macrotrichia of veins relatively small and sparse, beyond cord lacking on R_{2+3}, all but base of R_{1+2}, R_3, M_2, M_3 and M_4; lacking on basal third of R_{4+5} and M_1; trichia on outer third of basal section of basal section of Cu_1 and all of second section; present on outer half of 2nd A but virtually lacking on 1st A; strong trichia on prearcular anal vein. Venation: Cell R_3 strongly narrowed at midlength; petiole of cell M_1 shorter than m; m-cu at near three-fourths to four-fifths M_{3+4}.

Abdomen brownish yellow, basal tergite infuscated, bases of succeeding tergites narrowly brownish black, the outer margins narrowly buffy; seventh and eighth segments more brownish black; hypopygium dark reddish brown. Male hypopygium (Plate 2, fig. 14) with the tergite, *t*, narrowly produced into two low blackened lobes, separated by a very shallow emargination, bearing short black setæ, on ventral surface and nearer the midline more concentrated; cephalad of these setæ on ventral surface with a bifid sclerotized plate; lateral margins of ventral surface broadly infolded. Outer dististyle, *d*, angularly bent at midlength into a flattened paddle, its apex broadly obtuse; at bend with a conspicuous triangular lobe. Inner dististyle smaller, angularly bent at near one-fourth the length, expanded outwardly, margins strongly infolded, apex obliquely truncate.

Habitat.—Sikkim.

Holotype, male, Gey, altitude 11, 650 feet, in *Rhododendron* association, May 18, 1959 (*Schmid*).

The most similar species is *Tipula* (*Bellardina*) *tesselatipennis* Brunetti, which has the tergal armature of the hypopygium somewhat the same but differs in the ventral plates and structure of the dististyles. I have re-described the types of *tesselatipennis* in another paper [Rec. Indian Mus. **44** (1942) 36-37, fig. 2]. It should be noted that the nasus in this species is short but evident.

TIPULA (BELLARDINA) OENONE sp. nov. **Plate 2, fig. 15.**

Size large (wing of male 25 millimeters); general coloration of thorax brown and gray; frontal prolongation of head long, without nasus; wings brownish gray, with a restricted yellow pattern that does not include the arcular region or cell 2nd A; male hypopygium with the posterior border of tergite glabrous, subtruncate; outer dististyle trilobed.

Male.—Length, about 20 millimeters; wing, 25; antenna, about 5.7.

Female.—Length, about 22 millimeters; wing, 17; antenna, about 3.3.

Frontal prolongation of head elongate, subequal to the remainder, dark brown, without nasus, palpi black, a trifle longer than the prolongation. Antennæ with scape yellowish brown, pedicel brown, apex broadly yellow; flagellum dark brown, passing into brownish black, the apices of the proximal three or four segments paler; flagellar segments strongly incised, the basal enlargement conspicuous; verticils longer than the segments. Head brown, the low vertical tubercle more pruinose, with a chestnut brown area on either side adjoining the eye.

Pronotum brown, the protuberant central area of the scutum blackened. Mesonotal præscutum virtually covered by three brown stripes, darker in the allotype; in type, the central stripe paler brown, interspaces with long pale setæ; scutal lobes chestnut brown, central area paler; scutellum brownish gray, with long yellow setæ; mediotergite brownish gray, with a central darkened vitta, pleurotergite brown, the narrow elevated katapleurotergite more blackened. Pleura dark brown, variegated with brownish gray on the dorsal sternopleurite, posterior sclerites similar; sternopleurite and meron with long yellow setæ. Halteres with stem obscure yellow, knob slightly darkened.

Legs with coxæ and trochanters brownish gray; femora light brown, tips narrowly and inconspicuously darker; tibiæ reddish brown, tarsi passing into brownish black; claws of male with a basal tooth. Wings with the ground brownish gray, prearcular and costal regions more yellowed; a restricted yellow pattern, including a zigzag band across the cells basad of the cord, extending from before the stigma across R and M into cells Cu and 1st A, not including 2nd A; a series of small marginal spots in cells R_5 to M_4, the last small; subterminal brightenings in cells R_3 and R_5, connecting with the marginal area in cell R_3 to form a more or less evident T-shaped mark; stigma and areas at origin of Rs and over anterior cord darker brown; obliterative areas before and beyond stigma and across cell 1st M_2 more whitened; veins yellow. Veins unusually glabrous, with scattered macrotrichia on R_{2+3}, outer half of R_{4+5} and distal end of M_1; basad of cord with very few trichia on outer end of M and anal veins; a strong series on prearcular anal vein; squama with long trichia. Wings of female smaller than in male, as shown by measurements, the outer veins even more glabrous. Venation: Rs arcuated basally; cell M_1 short-petiolate, especially in female where the petiole is virtually lacking.

Abdomen dark chestnut brown, lateral tergal border blackened, posterior margins narrowly pale, outer segments more uniformly blackened; in female, ovipositor with both cerci and hypovalvæ blackened, relatively long. Male hypopygium (Plate 2, fig. 15) with the posterior border of tergite, *t*, subtruncate, the margin with two low lobes on either side of midline; ventral armature including longitudinal thickenings and pale circular membranous cushions that are very densely provided with microscopic setulæ. Ninth sternite with a group of long setæ. Outer dististyle, *d*, trilobed, the outer lobe a long simple rod, its tip acute, inner arm bilobed, one blade smaller, subglabrous, with small setæ only, the larger arm with numerous long yellow setæ. Inner dististyle massive, the triangular beak short; dorsal crest with numerous strong black setæ and a compact group of sensory pits. Gonapophyses long and narrow.

Habitat.—Sikkim.

Holotype, male, Chumzomoi Choka, altitude 11,800 feet, in *Rhododendron* association, July 8, 1959 (*Schmid*). Allotopotype, female, pinned with type.

Generally similar regional species, such as *Tipula* (*Bellardina*) *gregoryi* Edwards and *T.* (*B.*) *waltoni* Edwards, evidently are not closely allied to the present fly since they possess a nasus. The larger forms that similarly lack the nasus, including *T.* (*B.*) *brunettiana* Alexander, *T.* (*B.*) *schmidiana* sp. nov., and *T.* (*B.*) *wardi* Edwards, are quite different in coloration, venation, and hypopygial structure.

TIPULA (BELLARDINA) SCHMIDIANA sp. nov. **Plate 2, fig. 16.**

Allied to *brunettiana;* size large (wing of male about 35 millimeters); mesonotal præscutum brownish yellow with four stripes, the lateral pair white, crossing the suture onto the scutal lobes; wings subfalcate in outline, brownish white, with a clearer white longitudinal stripe at near midwidth; costal border and longitudinal stripes along Cu and in outer medial field brown; virtually all cells of wings with abundant brown dots, producing a freckled appearance; male hypopygium with the thumb of the outer dististyle relatively small.

Male.—Length, about 31 to 32 millimeters; wing 34 to 37; antenna, about 4.3 to 4.5.

Frontal prolongation of head long, slightly exceeding the remainder of head, without nasus; light gray above, brown on more than the lower half, the dorsal edge near eye still darker; palpi brown, terminal segment brownish black. Antennæ with scape light brown, with four transverse impressed lines on dorsal surface, with relatively few short setæ; pedicel brownish gray; flagellum brownish yellow, terminal segment darker; flagellar segments with small basal enlargements, verticils about one-third longer than the segments. Head light gray above, abruptly dark brown on genæ and beneath; a vague darkened capillary median vitta behind the low entire vertical tubercle.

Pronotum whitened, scutum with conspicuous setæ from brown punctures, the lateral ones longer; sides of scutellum produced into a blunt point. Mesonotal præscutum with the ground color of disk brownish yellow, lateral borders and posterior interspaces darker brown; four discal stripes, the intermediate pair yellowish gray, narrowly bordered by brown, lateral pair broader, whitened, conspicuously bordered by brownish black, broader on internal margin before suture; the white color crosses the suture onto the anterior ends of the scutal lobes, the latter dark-

er gray behind, internally with strong yellow setæ from brown punctures, central area of scutum gray, vaguely lined with darker; scutellum lighter gray, with setæ from brown punctures, parascutella dark brown; mediotergite light gray, patterned with three brown areas that are visible chiefly from above, provided with long erect setæ from brown punctures; lateral pair broader, pale brown, on anterior two-thirds, median line narrowed posteriorly and reaching the border on the otherwise light brownish gray caudal third; pleurotergite brown above, the katapleurotergite brown and tumid, its dorsal edge lined with silvery. Pleura brown, propleura and sides of cervical region dark brown; mesepisternum brownish gray, with a more whitened stripe across the dorsal sternopleurite; pteropleurite light gray beneath wing root, dark brown below; ventral part, with the metapleura, whitened; meron light brown with a narrow white dorsal line. Halteres brownish yellow, knob black. Legs with coxæ brownish gray, with abundant long setæ from vaguely darkened punctures; trochanters pinkish, pruinose; remainder of legs dark brown, outer tarsal segments black; claws of male with a relatively small basal tooth. Wings long and narrow, posterior border of outer half slightly concave to produce a subfalcate outline; ground color brownish white, clearer white at midwidth, cells C and Sc, with the stigma darker; longitudinal brownish gray stripes in base of cell Cu, beyond one-third the wing length crossing into the posterior margin of cell M; a comparable but narrower line in outer medial field, extending from fork of M across the outer end of cell 1st M_2 about to three-fifths the length of vein M_1; all wing cells beyond arculus sprinkled with small brown dots, less numerous in the radial field, more abundant posteriorly; anal cells washed with dusky, the outlines of the enclosed dots less distinct; apex of cell R_5 clear, the borders of the remaining posterior cells narrowly darkened, interrupted by three whitened spots in outer ends of anal cells; prearcular cells whitened, unpatterned; veins brownish yellow, only slightly darker in the patterned areas. Most veins beyond cord with short macrotrichia, lacking on outer two-thirds of R_{1+2} and extreme bases of R_{1+3} and M_1; vein 1st A glabrous except for a few trichia at either end, 2nd A glabrous on less than proximal half. Venation: R_2 very short to punctiform; vein R_3 long and sinuous, narrowing cell R_3 at near midlength; petiole of cell M_1 subequal to m.

Abdomen elongate, yellowish brown, basal tergite darker, pruinose on sides, freckled with brown punctures; margins of remaining tergites very narrowly light gray, bordered internally by a similarly narrow darker line; sternites light yellowish brown, their dorsal edges light gray; outer segments darker brown, including the relatively small hypopygium; segments with abundant short setæ from conspicuous brown punctures to produce a freckled appearance, virtually lacking mid-dorsally, more abundant and evident on tergites than on sternites. Male hypopygium (Plate 2, fig. 16) with the tergite, *t*, transverse, subrectangular in outline, lateral angles conspicuous; posterior border nearly truncate, fringed with abundant relatively short setæ, those of the outer angles longer; ventral plate four-toothed, lateral points directed laterad, intermediate pair separated by a deep U-shaped notch. Outer dististyle, *d*, mitten-shaped, the thumb a relatively small darkened brown point, outer third of style with abundant setæ, the outermost of these pale. Inner style with apex obliquely truncate, sensory area long and narrow.

Habitat.—Sikkim.

Holotype, male, Churong, altitude 12,460 feet, in *Rhododendron* association, April 18, 1959 (*Schmid*). Paratypes, 3 males, Tangshing, altitude 12,000 to 12,800 feet, in *Rhododendron* association, April 15 to 17, 1959 (*Schmid*); 1 male, Dzongri, altitude 13,222 feet, in *Rhododendron* association, April 14, 1959 (*Schmid*).

This large and striking crane-fly is dedicated to the collector, Dr. Fernand Schmid, to whom our present satisfactory knowledge of the Himalayan crane-fly fauna is chiefly due. The closest relatives are the equally large and striking *Tipula* (*Bellardina*) *brunettiana* Alexander and *T.* (*B.*) *wardi* Edwards, especially the former. The single most evident feature of the present fly is the abundant brown dotting in the wing cells, quite lacking in *brunettiana*.

TIPULA (SCHUMMELIA) LIOTERGA sp. nov. **Plate 1, fig. 1; Plate 2, fig. 17.**

Size medium (wing 13 millimeters); general coloration of notum brown, præscutum yellowed anteriorly, pleura yellow, dorsopleural membrane darkened behind; antennal flagellum black, segments with unusually long verticils; tibiæ and tarsi black, claws simple; wings yellow, conspicuously brightened in

the prearcular and costal fields; a restricted brown pattern including the stigma and very narrow seams on outer veins; macrotrichia of veins conspicuous, including a series on m-cu, cell 2nd A narrow; male hypopygium with posterior margin of the short transverse tergite trilobed; inner dististyle terminating in a slender decurved beak.

Male.—Length, about 11.5 millimeters; wing, 13; antenna, about 4.

Frontal prolongation of head brownish black, paler beneath; nasus very long and slender, longer than its terminal bristles; palpi black, outer two segments more pruinose. Antennæ with scape and pedicel light yellow, flagellum black; basal enlargements of flagellar segments small, more produced above and here with unusually long verticils that exceed the segments in length. Head with front and broad anterior vertex light gray, posterior part of head dark grayish brown, with abundant short black setæ on sides; no vertical tubercle.

Cervical region and pronotum yellow, scutum broadly infuscated above, with long erect pale setæ. Mesonotal præscutum with anterior end and the humeral region extensively yellowed, the remainder with four light brown stripes, the lateral pair and the broad margins darker brown; scutum brownish yellow, lobes with a major darker brown area; posterior sclerites of notum brown, with long erect pale setæ on scutellum and mediotergite; pleurotergite infuscated above, the katapleurotergite yellowed. Pleura yellow, the posterior two-thirds of the dorsopleural membrane conspicuously dark brown. Halteres infuscated, base of stem and apex of knob obscure yellow. Legs with all coxæ clear light yellow, trochanters darker yellow; femora yellow basally, outwardly passing through brown to black, remainder of legs black; fore tibiæ with a single spur; claws of male simple. Wings (Plate 1, fig. 1) yellow, the prearcular and costal fields conspicuously more saturated yellow; stigma oval, dark brown; veins of outer half of wing with conspicuous narrow brown seams to produce a striped appearance; veins brownish black, more yellowed in the brightened fields. Veins with conspicuous macrotrichia, extending back to arculus on Sc, R and 1st A, virtually to base on M, on Cu_1 lacking on more than proximal half; vein 2nd A with trichia on less than outer half; prearcular anal vein with strong trichia; several trichia on

m-cu; squama setose. Venation: Rs relatively long and straight, about one-half longer than m-cu; cell M_1 deep, its petiole subequal to or a trifle shorter than m; m-cu close to fork of M_{3+4}, the latter subequal to M_{1+2}; cell 2nd A narrow.

Basal abdominal tergites brownish yellow, with a broken median brown stripe, interrupted at posterior borders, lateral margins narrowly darkened near outer ends; basal sternites clear light yellow, outer segments passing into black. Male hypopygium (Plate 2, fig. 17) with the tergite, *t*, unusually short and broad, narrowed posteriorly, the margin with broad lateral lobes and a narrower median one, this subacute at tip; outer margin glabrous, disk and sides with setæ of normal size. Outer dististyle, *d*, pale, about four to four-and-one-half times as long as wide, with pale setæ. Inner dististyle simple, pale throughout, including a slender slightly decurved beak, its tip narrowly obtuse, lower beak broader, glabrous; region of dorsal crest protuberant, densely clothed with delicate yellow setæ and fewer strong pale setæ; outer basal lobe a smaller protuberance, with a few stout darkened setæ, posteriorly these more slender, yellow, on opposite margin near base with a low oval protuberance, with abundant long setæ. Ædeagus slender, blackened, without developed apophyses. Eighth sternite narrowly transverse, margin truncate, unmodified, with unusually few or less setæ on the outer fourth.

Habitat.—Sikkim.

Holotype, male, Chateng, altitude 8,700 feet, May 22, 1959 (*Schmid*).

I am assigning this distinct fly to *Schummelia* with some slight question. The antennal verticils and some features of the venation are more as in *Indotipula* but the tibial spur formula and other characters place it in *Schummelia*. It is quite distinct from other species in the diagnostic features listed, especially the coloration and venation of the wings and the structure of the hypopygium, particularly the tergite and inner dististyle.

TIPULA (SCHUMMELIA) NOBILIOR sp. nov. **Plate 2, fig. 18.**

Size very large (wing of male 18 millimeters or more); antennal flagellum black; mesonotal præscutum with four brown stripes that are narrowly bordered by darker brown; knobs of

halteres light yellow; wings strongly darkened, conspicuously variegated with whitened spots, stigma darker brown; male hypopygium with the tergite appearing as a narrowly transverse blackened plate; outer dististyle unusually long and slender, inner style irregular in conformation.

Male.—Length, about 16 millimeters; wing, 18.5; antenna, about 5.5.

Female.—Length, about 19 millimeters; wing, 23; antenna, about 3.8.

Frontal prolongation of head obscure yellow above, somewhat darker below, with a narrow still darker line between the two, nasus short; palpi with first segment yellowed, two and three dark brown, with pale incisures, terminal segment black. Antennæ with scape and pedicel yellow, flagellum black; flagellar segments in male weakly enlarged at base, a little exceeding their longest verticils; antennæ of female shorter. Head dark brown, paler behind, orbits broadly yellow in front, narrowed behind; vertical tubercle low.

Pronotal scutum brown, yellowed laterally, scutellum light yellow. Mesonotal præscutum with four brown stripes that are narrowly bordered by darker brown, the anterior third of intermediate stripes much darker brown; outer margin of humeral region dark brown, enclosing a slightly larger triangular light yellow area immediately before the lateral stripes; lateral margins of præscutum pale brown, variegated internally by two vague more yellowed spots; each scutal lobe with two yellowish brown areas bordered by darker brown; scutellum brown, in female more yellowed, with a darker central line, parascutella paler; mediotergite obscure yellow with a large pale brown area on either side of midline of anterior two-thirds, not evident in female; pleurotergite yellowed; setæ of præscutum very small and sparse, longer on scutellum and mediotergite. Pleura chiefly dark brown, the dorsal sternopleurite and anepisternum paler; dorsopleural membrane and posterior pleurites yellow. Halteres with stem dusky, base narrowly more yellowed, knob light yellow. Legs with fore coxæ dark brown, paler apically, mid-coxæ darkened on anterior face, yellowed behind; posterior coxæ with a much smaller dark brown spot; trochanters brownish yellow; femora brownish black, restrictedly more yellowed basally, tips more blackened; tibiæ brownish black, genua nar-

rowly and inconspicuously whitened; tarsi black; claws simple. Wings strongly darkened, conspicuously variegated with whitened spots; stigma darker brown; cells C and Sc more yellowed, especially the latter; the white spots are before and beyond stigma, across base of cell 1st M_2, near outer end of cell M, extended into cell Cu; two in cell 1st A, the basal one extended into Cu; bases of all outer medial cells with a whitened spot, in cells M_3 and M_4 these being part of the obliterative area at base of cell 1st M_2; veins dark brown, Sc and R more yellowed. Most longitudinal veins beyond arculus with macrotrichia over virtually their whole length, lacking on basal section of Cu_1. Venation: Petiole of cell M_1 shorter than m; Rs and m-cu subequal.

Basal segments of abdomen yellow, patterned with brown, the apices of the second and succeeding segments dark brown, the posterior borders narrowly pale; outer sternites darkened; hypopygium black. Male hypopygium (Plate 2, fig. 18) with the tergite, *t*, very broadly transverse, appearing as a narrow blackened plate, more expanded laterally, the central region narrow; surface with a few small setæ. Outer dististyle, *d*, unusually long and slender, broadest at base, tapering very gradually to the narrowly obtuse apex, with numerous setæ, those of outer margin very long, the longest about one-third the style. Inner dististyle of unique conformation, as shown; beak and lower beak blackened, the former a little larger; outer basal lobe dilated, lower posterior margin with two blackened spines, one more slender, the two spines more or less decussate.

Habitat.—Sikkim.

Holotype, male, Chumzomoi Choka, altitude 11,800 feet, in *Rhododendron* association, July 8, 1959 (Schmid). Allotype, female, Lachen, altitude 8,900 feet, June 13, 1959 (*Schmid*).

Tipula (*Schummelia*) *nobilior* is the largest species of the subgenus in the local fauna, differing from other regional forms not only in the great size but likewise in the wing pattern and structure of the male hypopygium, including especially the tergite and inner dististyle.

TIPULA (SCHUMMELIA) PENICILLARIS sp. nov. **Plate 1, fig. 2; Plate 2, fig. 19.**

Size medium (wing, about 12 millimeters); mesonotal præscutum with four brown stripes that are narrowly bordered by

darker brown; pleura brown, narrowly lined with yellow; base of knob of halteres dark brown, apex broadly light yellow; femora obscure yellow, tips conspicuously blackened, claws of male toothed; wings broad, infuscated, variegated by creamy areas; Rs relatively long and straight; male hypopygium with outer dististyle entirely pale, long and narrow.

Male.—Length, about 12 millimeters; wing, 12 to 12.5; antenna, about 3.5.

Female.—Length, about 13.5 millimeters; wing, 12.5.

Frontal prolongation of head relatively long, darkened above, obscure yellow on sides; nasus stout; palpi dark brown. Antennæ of male with scape and pedicel light yellow, first flagellar segment light brown, outer segments brownish black; flagellar segments exceeding their verticils, with moderate basal enlargements; terminal segment not exceeding one-half the penultimate; in female, proximal flagellar segments brownish yellow to light brown, pedicel more brightened, flagellum dark brown. Head yellow behind eyes and on orbits, the center of vertex broadly brown, posterior part of head brownish yellow; anterior vertex broad, nearly equal to the exposed part of eye; no vertical tubercle.

Pronotum brown. Mesonotal præscutum with four brown stripes that are narrowly bordered by darker brown, this forming the median vitta; interspaces obscured, especially in front; humeral and lateral margins broadly light yellow; scutal lobes brown, the central area pale; scutellum and mediotergite weakly infuscated on either side, central area obscure yellow, pleurotergite pale, silvery pruinose. Pleura chiefly brown, narrowly lined with yellow, sternopleurite more broadly pale; dorsopleural membrane darkened. Halteres with stem yellowish brown, brighter basally, knob dark brown, apex broadly light yellow. Legs with coxæ yellow, outer faces slightly darkened, especially on fore coxæ; trochanters testaceous yellow; femora obscure yellow, tips conspicuously blackened, the amount subequal on all legs and including about the distal eighth of segment; tibiæ brown, tarsi black; claws of male haIry basally, with a small tooth. Wings (Plate 1, fig. 2) broad, infuscated, variegated with creamy areas; prearcular and costal fields brownish yellow; pale spots before and beyond stigma, across base of cell 1st M_2, two areas in cell M, with others in cells Cu and 1st A;

cell M_1 extensively pale; veins pale, more yellowed in the brightened fields, whitened in the obliterative areas. Longitudinal veins with numerous macrotrichia, including the basal half of R_{1+2} and outer end of 1st A. Venation: Rs relatively long and straight, subequal to m-cu.

First abdominal tergite brown, succeeding segments yellow or brownish yellow, narrowly darkened laterally, the outer three or four segments brownish black. Ovipositor with cerci straight, very long and slender. Male hypopygium (Plate 2, fig. 19) with posterior border of tergite, *t*, gently emarginate, with a broad median projection that may be bent cephalad beneath the margin (upper figure) or projecting (lower figure), presenting quite different appearances; small obtuse lateral knobs or blunt teeth. Outer mesal angle of basistyle or adjoining base of dististyle with a stout lobe that bears about 15 to 20 very long stout dark-colored setæ, these about three-fourths the length of the inner dististyle. Outer dististyle, *d*, long and narrow, pale throughout, basal setæ conspicuous, outer ones small and weak; inner style as shown, its dorsal crest very long, produced backward into an obtuse lobe; surface of style with long erect pale setæ, on opposite face with microscopic black setæ that are directed backward. Phallosome including the slender black ædeagus, *a*, and circular disklike apophyses, with extremely minute setulæ and abundant roughened tubercles. Eighth sternite unmodified.

Habitat.—India (Kumaon).

Holotype, male, Dakwani, Pauri Garhwal, altitude 9,300 to 11,000 feet, August 7, 1958 (*Schmid*). Allotopotype, female, pinned with type. Paratypes, males and females, Kulara, Pauri Garhwal, altitude 12,000 feet, August 4, 1958 (*Schmid*).

The most similar regional species is *Tipula* (*Schummelia*) *chumbiensis* Edwards, which likewise has broad wings with a comparable pattern. This differs in the coloration of the thorax and legs, simple claws, darkened outer dististyle, and other characters.

TIPULA (ACUTIPULA) INDRA sp. nov. **Plate 2, fig. 20.**

Size large (wing of male about 20 millimeters); antennæ short; mesonotum generally dark brown, pleura and the broad margins of præscutum and mediotergite yellow; wings brown,

patterned with dark brown and whitened areas, the obliterative mark at cord very conspicuous; abdomen yellowish brown, outer segments black; male hypopygium with tergal lobe spiculose, entire, subtended by conspicuous shoulders; outer lobe of inner dististyle produced into a small outer blade and a more basal powerful spine; outer dististyle about twice as long as broad; eighth sternite with posterior border emarginate, the broad rounded lobes fringed with relatively short setæ and covered with abundant blackened spicules.

Male.—Length, about 14 to 15 millimeters; wing, 19 to 20; antenna, about 2.8 to 2.9.

Frontal prolongation of head dark brown, including the broad nasus; palpi black. Antennæ short; scape and pedicel yellowish brown, flagellum darker brown; flagellar segments subcylindrical, without well developed basal enlargements, a little shorter than the longest verticils. Head dark brown, the front and antennal fossæ restrictedly more yellowed.

Pronotum yellow. Mesonotal præscutum with the anterior and lateral borders yellow, disk with four grayish brown stripes that are broadly margined by slightly darker brown lines that are subequal in diameter to the stripes, the intermediate pair paling to orange at anterior end; posterior sclerites of notum dark brown, vaguely pruinose; mediotergite with lateral borders broadly light yellow, the color continued forward onto the dorsal pleurotergite, the center of the latter weakly darkened. Pleura orange yellow, including the dorsopleural membrane. Halteres long, dark brown, apex of knob paler. Legs with coxæ and trochanters yellow; remainder of legs black, femoral bases narrowly obscure yellow; claws of male toothed. Wings brown, prearcular and costal fields more yellowed; stigma and an area at end of Sc darker brown; a conspicuous brown mark beyond one-third the length of cell Cu, with a further darkening in outer end of cell M near m-cu; obliterative area before cord extending from before stigma across cell 1st M_2, continuous and very conspicuous; comparable whitened areas before and beyond the dark mark in cell Cu; slightly more yellowed areas beyond midlength of cell M, base of cell M_4 and narrowly in bases of cells M_1, 2nd M_2, and near outer end of R_5; cell Cu_1 (the narrow space between the cubital branches) darkened; veins dark brown, more yellowed in the brightened fields. Veins beyond cord with

a few macrotrichia on M_{1+2} and basal half of M_2; before cord with very sparse trichia on Rs, M, anals, and near base of Cu. Venation: Rs subequal to m-cu or R_{2+3}; petiole of cell M_1 and m subequal; m-cu on M_{3+4} before fork.

Abdominal tergites yellowish brown, basal ones narrowly more darkened sublaterally, the actual borders narrowly whitened, sternites clearer yellow; segments six to nine, including the large hypopygium, with the exception of the outer dististyle, black. Male hypopygium (Plate 2, fig. 20) with the tergite, *t*, produced posteriorly into a depressed median lobe, the short tip broad, entire, subtended by conspicuous shoulders, the apices of all with abundant blackened spicules. Ninth sternite with a very small lobe bearing a compact pencil of unusually long yellow setæ. Outer dististyle, *d*, white, about twice as long as its greatest width, before apex with the outer margin gently emarginate; setæ sparse, chiefly along border. Inner dististyle with the beak relatively slender, outer lobe large, produced into a powerful spine, with a smaller flattened blade beyond, the lobe virtually glabrous; sensory area large; before midlength of style with a transverse row of setæ, the outer ones stronger. Eighth sternite, *8s*, large, posterior border emarginate, lateral lobes broadly rounded, fringed with relatively short yellow setæ and densely covered with short blackened spicules, those of the median area long and normal, the emargination filled with pale membrane that is densely setuliferous.

Habitat.—Sikkim.

Holotype, male, Lathong, altitude 6,560 feet, May 15, 1959 (*Schmid*). Paratopotypes, 3 males.

The most similar regional described species is *Tipula* (*Acutipula*) *interrupta* Brunetti, which likewise has the apical lobe of the tergite entire, differing conspicuously in all structures of the hypopygium, including the tergite, eighth sternite, and both dististyles.

TIPULA (ACUTIPULA) KUMPA sp. nov. **Plate 3, fig. 21.**

Size large (wing of male 24 millimeters); mesonotal præscutum light brown with four more yellowed stripes, the lateral borders clearer yellow; scutellum conspicuously patterned; wings with a darkening before midlength of cell Cu; bases of outer medial cells slightly whitened; male hypopygium with the apical lobe of tergite shallowly divided; outer dististyle broad, bilobed

at apex; outer lobe of inner style broad, with about 20 short reddish spines; eighth sternite with posterior border very shallowly emarginate, the low lateral lobes with short inconspicuous setæ.

Male.—Length, about 22 millimeters; wing, 24; antenna, about 3.

Frontal prolongation of head dark chestnut brown; nasus elongate, with long black setæ; palpi black. Antennæ with scape and pedicel brownish yellow; flagellum brownish black, the tips of the segments slightly paler to produce a weak bicolored appearance, outer segments more uniformly brownish black; basal enlargements of segments scarcely developed; verticils shorter than the segments. Head with anterior vertex brownish gray, posterior vertex chiefly brownish black, posterior orbits narrowly reddened.

Pronotum brownish yellow, clearer yellow on sides. Mesonotal præscutum with the ground light brown, with four poorly indicated more yellowed stripes, lateral margins clearer yellow; scutum plumbeous, each lobe with two brown areas, the anterior one smaller and more distinct; scutellum with a plumbeous basal darkening, posterior border with two circular rich brown spots, parascutella brownish gray; mediotergite broadly rich brown, lateral margins light yellow; pleurotergite and pleura light yellow, in the type badly damaged by Corrodentia but apparently unpatterned. Halteres brownish black, extreme tip of knob yellowed. Legs with coxæ and trochanters yellow; remainder of legs brownish black to black, claws toothed. Wings patterned much as in *robusta* and some other species, medium brown, the stigma, a cloud near outer end of cell M and one before midlength of Cu darker brown, the last preceded and followed by whitened areas; other pale marks include one in cell M before the darkened part, before cord, posterior end of m-cu, and a restricted area in bases of cells M_1, 2nd M_2 and M_3; veins brown. Venation: Rs subequal to m-cu; petiole of cell M_1 subequal to m; m-cu shortly before fork of M_{3+4}.

Abdominal tergites brownish yellow, the basal rings narrowly more pruinose, posterior borders very narrowly darkened, sublateral parts weakly infuscated, the actual borders yellow; outer segments brownish black, central region of eighth sternite and the styli yellowed. Male hypopygium (Plate 3, fig. 21)

with the posterior border of the tergite, *t*, produced into a relatively slender lobe that is divided into two lobules by a relatively short split, the lobues with abundant small spinules. Ninth sternite, *9s*, with a stout lobe tipped with a dense brush of long setæ. Outer dististyle, *d*, broad, apex shallowly emarginate to form two unequal lobes; vestiture short and sparse. Inner dististyle distinctive; beak slender, especially the apex; outer lobe extensive, produced into a stouter beaklike extension, the outer part with about twenty short stout reddish spines; region of outer basal lobe produced, tipped with about four small spines and more numerous longer setæ. Eighth sternite, *8s*, narrowed outwardly, posterior border very shallowly emarginate, the very low lateral lobes with a concentration of short inconspicuous setæ; posterior border with exceedingly numerous and dense small pale setæ.

Habitat.—Sikkim.

Holotype, male, Chumtang, altitude 5,120 feet, July 30, 1959 (*Schmid.*)

The specific name, *kumpa*, is that of a Sikkimese tribe discussed by Hooker in the "Himalayan Journals." The fly is quite distinct from other large-sized regional members of the subgenus in the pattern of the mesonotum and especially in the structure of the male hypopygium, including the dististyles and eighth sternite.

TIPULA (ACUTIPULA) SICULA sp. nov. **Plate 3, fig. 22.**

Size large (wing of male about 23 millimeters); general coloration of præscutum olive gray with four slightly darker stripes that are narrowly margined with brown, pleura yellow; legs very long, black, femoral bases narrowly obscure yellow; wings with anterior half darker brown, posterior part paler, more brownish gray, with darkened areas, especially at base of outer radial field, outer end of cell M and at near midlength of cell Cu; extensive whitened areas on disk; outer radial and medial veins without macrotrichia, anal veins with trichia throughout their lengths; basal abdominal segments light brown, outer segments, including hypopygium, dark brown; male hypopygium with tergite narrowed outwardly, the outer blade split into two slender spiculose lobes; outer lobe of inner dististyle produced into a long needlelike spine, subtended by numerous long powerful setæ; eighth sternite unmodified.

Male.—Length, about 22 millimeters; wing, 23.5; antenna, about 3.5.

Fore leg, femur, 16; tibia, 19, basitarsus, 25.

Hind leg, femur, 19; tibia, 22; basitarsus, 33.

Frontal prolongation of head brownish gray, nasus black, elongate; palpi black. Antennæ relatively short; scape brownish yellow, pedicel clearer yellow, flagellar segments beyond the second bicolored, the small basal swelling black, remainder yellow, the latter color becoming more obscure on outer segments; verticils long, nearly twice the segments. Head dark gray; anterior vertex flat, with a blackened area on either side, narrowly separated at the midline.

Pronotum clear orange yellow. Mesonotal præscutum with the ground olive gray, with four slightly darker stripes that are narrowly margined with brown, the cephalic border conspicuously dark brown, lateral margins yellowed, more extensively so before the suture; point of the suture impressed and blackened; scutum olive gray, each lobe with two scarcely darker areas that are indicated by narrow brown margins; scutellum brownish gray with a very faint darker central line, parascutella brownish yellow, gray ventrally; mediotergite brownish gray, the posterior third and broad lateral margins yellow; pleurotergite obscure yellow above, the katapleurotergite brighter yellow; præscutum with sparse short setæ, scutellum and mediotergite with long erect yellow setæ. Pleura yellow, including the more orange yellow dorsopleural region, the latter a little darker posterioly. Halteres dark brown, base of stem narrowly yellowed. Legs with coxæ; trochanters testaceous yellow; remainder of legs black, femoral bases narrowly obscure yellow; claws toothed; legs very long, as shown by the measurements. Wings with anterior half darker brown, the posterior part paler, more brownish gray, with darker areas in bases of outer radial cells beyond cord, in outer end of cell M and at near midlength of cell Cu; large and conspicuous whitened areas before cord, at near two-thirds the length of cell M, and before and beyond the dark marking in cell Cu; bases of outer medial cells a trifle paler than their centers, the apices narrowly darkened; stigma long, darker brown than the ground; veins dark brown. Outer radial and medial veins without macrotrichia, even lacking on R_{1+2}; M and both anals with trichia over virtually their entire

lengths. Venation: Rs subequal to or a trifle longer than m-cu; R_{1-2} turned cephalad on outer third; petiole of cell M_1 a little shorter than m, M_{3-4} shorter than basal section of M_2; cell 2nd A broad.

Abdomen light brown, the lateral and posterior borders of the basal and intermediate segments narrowly darker, the extreme edges pale; basal sternites yellow, more distal ones brown; outer segments, including hypopygium, dark brown. Male hypopygium (Plate 3, fig. 22) with the tergite, *t*, narrowed outwardly, produced into a broad yellow blade that is narrowly split at apex by a U-shaped notch to form two narrow lobes that are set with blackened spicules. Ninth sternite on either side with a dense brush of long yellow setæ. Other dististyle, *d*, pale, tip broadly rounded, the length about two and one-half times the greatest width, which is at near one-third the length; setæ short and scattered, from small punctures. Inner style with the beak powerful, obtuse at tip; outer lobe a little smaller, its inner apical angle produced into a long needlelike spine, the adjacent part of apex with about a score of long powerful setæ, the longest slightly exceeding the spine, the more basal ones shortest; sensory area lying in the angle between the beak and the outer lobe. Gonapophyses appearing as narrow paddlelike blades. Eighth sternite unmodified.

Habitat.—Sikkim.

Holotype, male, Manu, altitude 4,920 feet, May 10, 1959 (*Schmid*).

Although generally similar to other regional members of the subgenus, especially *Tipula* (*Acutipula*) *robusta* Brunetti, the present fly differs conspicuously in the male hypopygium. In *robusta* more than the basal half of cell M of the wings is whitened whereas in the present fly it is infuscated.

TIPULA (ACUTIPULA) TRIPLACA sp. nov. **Plate 1, fig. 3; Plate 3, fig. 23.**

Allied to *quadrinotata;* mesonotum dark brownish gray, præscutum with four inconspicuous darker brown stripes, anterior border conspicuously blackened; pleura clear light yellow below; wings suffused with brown, restrictedly patterned with darker, including the costal border; male hypopygium with the tergite terminating in three flattened yellow blades, all provided with abundant blackened spicules; eighth sternite broad, posterior

border truncate, lateral angles weakly produced, with a broad group of yellow setæ.

Male.—Length, about 16 millimeters; wing, 19; antenna, about 3.

Frontal prolongation of head, including nasus, dark brown, palpi black. Antennæ relatively short; scape brownish yellow, pedicel yellow, basal flagellar segments weakly bicolored, darker on proximal portion, the tips paler, outer segments more uniformly dark brown; flagellar segments much shorter than the longest verticils. Head dark brown; anterior vertex relatively narrow.

Pronotum dark brown. Mesonotal præscutum with the ground dark brownish gray, disk almost covered by four darker brown stripes that are inconspicuous against the ground, subhumeral and sublateral areas obscure yellow, the anterior border narrowly margined with black; posterior sclerites of notum brownish black, the scutellum posteriorly more intensely blackened; mediotergite brownish gray, yellowed laterally, pleurotergite with central part dark brown, the dorsal and ventral portions yellowed. Pleura brownish yellow dorsally, passing into clear light yellow below, dorsopleural membrane dusky. Halteres brownish black, extereme base of stem reddened, apex of the small knob slightly paler. Legs with coxæ and trochanters pale yellow; femora brownish yellow, clearer basally, the tips conspicuously blackened, the amount subequal on all legs; tibiæ and tarsi brown, the terminal tarsal segments brownish black; claws of male toothed. Wings (Plate 1, fig. 3) suffused with brown, stigma and costal border darked brown; relatively large brown clouds near outer end of cell R adjoining vein M and before midlength of cell Cu, both clouds preceded and followed by more whitened areas; very faint dusky clouds beyond anterior cord, outer end of cell 1st M_2 and fork of M_{1+2}; obliterative area at cord conspicuous; slight whitened areas on veins M_1, M_2 and M_3 immediately distad of the darkened parts; veins brown. Macrotrichia on veins R_3 and R_{1+5}, lacking on outer medial and cubital branches; both anal veins with scattered but virtually complete series of small trichia. Venation: Petiole of cell M_1 and m subequal; m-cu just before outer end of M_{3+4}.

Abdominal tergites reddish brown medially, darker brown lateraly, subterminal segments and hypopygium dark brown;

basal sternites yellowed, becoming darker outwardly. Male hypopygium (Plate 3, fig. 23) with the tergite, *t*, terminating in three flattened yellow blades, subequal in size and shape, all with tips obtuse and provided with small blackened spicules over virtually the whole surface; lateral blades slightly more oblique than the vertical central one; surface at base of blades with long reddish setæ. Outer dististyle, *d*, narrowed on outer half, setæ small and sparse; inner style generally as in *quadrinotata*, with two spines, the outer one larger, near its base with a group of long yellow setæ; both beak and lower beak relatively small, triangular in outline; a small conical lobe at apex of basistyle, provided with long yellow setæ. Gonapophyses appearing as divergent brownish yellow blades. Eighth sternite, *8s*, broad, posterior border truncate, lateral angles weakly produced, with a broad group of yellow setæ.

Habitat.—North Bengal.

Holotype, male, Kurseong, Darjeeling District, altitude 5,455 feet, August 18, 1958 (*Camilleri*).

The most similar regional species is *Tipula* (*Acutipula*) *quadrinotata* Brunetti, which differs most evidently in the structure of the male hypopygium, particularly the tergite, which has only two spiculose blades, as is common in the subgenus.

TIPULA (ANOMALOPTERA) BATHROXANTHA sp. nov. **Plate 3, figs. 24, 25.**

Size medium (wing of male about 12 millimeters); mesonotum yellow, præscutum with four brown stripes: antennæ of male elongate, all flagellar segments black with light yellow bases; femora obscure yellow, outer segments of leg darker; wings brownish yellow, stigma distinct; male hypopygium with the beak of the inner dististyle slender, heavily blackened, outer basal lobe large.

Male.—Length, about 13 millimeters; wing, 12.2; antenna, about 5.2.

Frontal prolongation of head yellow, nasus concolorous, elongate; palpi testaceous yellow, distal end of terminal segment more orange. Antennæ relatively long, as shown by the measurements; scape and pedicel yellow, flagellar segments bicolored, their bases yellow, the outer ends more extensively brownish black, the bicolorous nature persisting to the terminal seg-

ment: basal enlargements moderately developed, verticils shorter than the segments. Head pale brown, the front, vertex surrounding the antennal fossæ and the orbits more yellowed; no vertical tubercle.

Pronotal scutum brownish orange, the sides and the scutellum clearer yellow. Mesonotal præscutum yellow, with four entire light brown stripes, the intermediate pair virtually confluent at the midline, their anterior fourth paling to brownish yellow; scutum yellow, the lobes inconspicuously grayish brown; scutellum and postnotum testaceous yellow; præscutum nearly glabrous, with microscopic setæ on the anterior interspaces; vestiture of scutellum and mediotergite black, longer and more conspicuous, especially on the sides of the mediotergtie behind, pleurotergite glabrous. Pleura yellow above, vaguely whitish pruinose below. Halteres short, stem obscure yellow, knob infuscated. Legs with coxæ yellow, trochanters more orange; femora obscure yellow, vestiture short; tibiæ brown, obscure yellow basally, tarsi passing into brownish black; claws small, simple. Wings brownish yellow, clearer yellow basally and in costal region, especially cell Sc, stigma oval, medium brown; veins brownish yellow, clearer yellow in the brightened parts. Wing tip weakly notched at termination of veins M_1 or M_2, the condition similar in both wings of the type. Outer veins of radial field and distal ends of veins M_1 and M_2 with macrotrichia, these lacking on R_{1-2} and M_3, sparse on M_4; an almost complete series on distal section of Cu_1 and the outer end of the basal section; Sc with a complete series of trichia; anal veins glabrous, including the prearcular section. Venation: Sc_2 ending just before midlength of Rs, the latter arcuated, subequal to m-cu; cell M_1 sessile or with the petiole very short; M_{3-4} short, subequal to the vertical basal section of M_4.

Abdomen with basal tergite and proximal four sternites obscure yellow, succeeding tergites light brown, fifth and following segments brownish black, the hypopygium more yellowed, especially distally. Male hypopygium (Plate 3, fig. 24) with the tergite, *t*, emarginate posteriorly, the inner borders of the broad lobes with about 15 short blackened spicules; proctiger large and conspicuous, hairy on sides. Outer dististyle, *d*, with the spine broad-based, blackened, slightly upcurved; inner style with the beak slender, heavily blackened, lower beak broad-based, tapering to the narrowly obtuse tip; outer basal lobe a

broad fleshy structure with scattered small setæ. Gonapophysis very long and narrow, pale. Sternal spatula, *8s*, broad, parallel-sided or very slightly widened outwardly, apex truncated, very obtuse, surface with very abundant evenly distrbiuted setulæ.

Habitat.—Kashmir.

Holotype, male, Gilgit, altitude 4,770 feet, June 9, 1954 (*Schmid*).

There now are four known species of *Anomaloptera*, including the subgenotype, *Tipula* (*Anomaloptera*) *nigra* Linnæus, of Europe, together with *T.* (*A.*) *ligulifera* Alexander, of eastern Siberia, *T.* (*A.*) *xanthocera* Alexander, of Kashmir, and the present fly. All have the basic structure of the male hypopygium generaly alike but with the details, especially of the inner dististyle, quite distinct. The present fly differs from *xanthocera* not only in the coloration of the body and antennæ but likewise in the wing trichiation and in the structure of the hypopygium, particularly the inner dististyle. I am figuring the dististyle of *xanthocera* for comparison (Plate 3, fig. 25, d), calling attention to the unusual length of the style, its unblackened obtuse beak and the greatly reduced outer basal lobe.

Mannheims [in Lindner, Die Fliegen 170 (1952) 107] calls attention to the characters in the present subgenus that serve to connect it with the genus *Nephrotoma* Meigen. There can be little question but that *Anomaloptera*, together with *Schummelia* Edwards and *Trichotipula* Alexander, are the groups that are most nearly allied to *Nephrotoma* and likewise to *Dolichopeza*.

TIPULA (INDOTIPULA) DIACAENA sp. nov. **Plate 1, fig. 4; Plate 3, fig. 26.**

Size relatively large (wing of male 13.5 millimeters); general coloration of mesonotum medium brown, pleura yellow, the mesepisternum chiefly brown; veins M_1 and M_2 with macrotrichia; male hypopygium with the posterior border of tergite trilobed; inner dististyle very high, the beak appearing as a deep cleaver-like blade, lower beak slender, blackened; outer basal lobe a large blackened structure that terminates in two strong black spines.

Male.—Length, about 11 millimeters; wing, 13.5; antenna, about 4.2.

Frontal prolongation of head yellow above, brown laterally and beneath; nasus elongate; palpi brown. Antennæ of male relatively long; scape and pedicel yellow, flagellum black; flagellar segments with basal enlargements small, longest verticils nearly equal to the segments. Head with front and cephalic part of anterior vertex light yellow; posterior part of head dark brownish gray with a more blackened spot on orbits at narrowest point of the vertex, sending a median extension onto the very low impressed vertical tubercle.

Pronotum medium brown, sides light yellow. Mesonotal præscutum yellow laterally, more obscured in front, disk medium brown, more intense laterally, the central area behind more yellowed; scutum brownish yellow, central area slightly more yellowed with a vague dusky median line, scutellum obscure yellow, parascutella darker; mediotergite weakly infuscated on disk, lateral and posterior parts more yellowed, with indications of a narrow pale central line, pleurotergite brown. Pleura yellow, the anterior two-thirds of the mesepisternum brown, to form a transverse girdle. Halteres brownish black, apex of knob vaguely paler. Legs with coxæ yellow, trochanters more testaceous yellow; remainder of legs broken. Wings (Plate 1, fig. 4) strongly suffused with brown, prearcular and costal regions, with cell Cu_1, more brownish yellow; stigma darker brown; small obliterative areas before stigma and across base of cell 1st M_2; veins brown. Most veins beyond cord with macrotrichia, including M_1 and M_2, sparse on M_3, lacking on M_4; a very few trichia on outer ends of veins M and 2nd A, lacking or reduced to one or two on Cu and 1st A. Venation: Cell M_1 deep, its petiole about two-thirds to three-fourths m; cell 2nd A narrowly.

Abdominal tergites dark brown, extreme posterior borders silvery, sternites more yellowed, hypopygium darkened. Male hypopygium (Plate 3, fig. 26) with the tergite, *t*, large, narrowed posteriorly, the outer third more yellowed, margin conspicuously trilobed, the broad lateral lobes heavily blackened, borders obscurely toothed, with coarse black punctures, median lobe smooth, terminating in a very obtuse blackened point. Ninth sternite with oval lobes provided with conspicuous yellow setæ, the lateral ones longer. Outer dististyle, *d*, long and narrow, tapering outwardly, with very long marginal setæ; inner style very high, the beak appearing as a deep cleaverlike blade, lower

beak slender, blackened; outer basal lobe a large blackened structure that terminates in two strong black spines, the lower one longer. Gonapophyses appearing as paddlelike blades. Eighth sternite with posterior border broadly convex, the posterior half with relatively sparse setæ of moderate length.

Habitat.—Sikkim.

Holotype, male, Palam, altitude 5,100 feet, April 25, 1959 (*Schmid*).

Tipula (*Indotipula*) *diacaena* resembles other regional species of the subgenus, as *T.* (*I.*) *sudra* sp. nov. and *T.* (*I.*) *varuna* sp. nov., differing very conspicuously in the structure of the male hypopygium.

TIPULA (INDOTIPULA) GUPTA sp. nov. **Plate 3, fig. 27.**

Size medium (wing of male 12.5 millimeters); general coloration of mesonotal præscutum brown, lateral and humeral borders yellow, pleura chiefly yellow; wings strongly tinged with brownish yellow, stigma distinct, obliterative area at base of cell 1st M_2 large and conspicuous; outer radial and medial veins with abundant macrotrichia; male hypopygium with tergal lobes large, spiculose; inner dististyle short and compact, beak very large, lower beak small, blackened, no well-developed outer basal lobe.

Male.—Length, about 10.5 millimeters; wing, 12.5; antenna, about 4.

Frontal prolongation of head fulvous yellow, paler yellow beneath, nasus yellow; palpi with extreme base yellowed, remainder brown. Antennæ with scape and pedicel light yellow, the outer end of scape slightly darker, flagellum black; flagellar segments with small basal enlargements, longest verticils nearly equal to the segments. Front and anterior vertex behind the antennal bases yellow, posterior part of head brown, with a vague more blackened central line that extends cephalad as a fine point into the notch of the very low vertical tubercle, orbits with a similar vague darkened spot.

Cervical region yellow. Pronotal scutum yellow, weakly patterned with three pale brown spots, scutellum yellow. Mesonotal præscutum with the disk chiefly covered by four brown stripes, the intermediate pair vaguely margined with darker,

lateral stripes more solidly darkened, lateral and humeral regions light yellow; scutum with lobes light brown, darker brown laterally, including the outer end of the suture, central area of scutum broadly yellow; scutellum yellow, parascutella slightly darker; mediotergite clear yellow, virtually glabrous, with two or three long setæ on either side, pleurotergite yellow, narrowly more darkened posteriorly, katapleurotergite in front extensively paler yellow. Pleura yellow, the propleura slightly infuscated, anterior half of mesepisternum less evidently so. Halteres with stem infuscated, knob dark brown. Legs with all coxæ and trochanters yellow; femora brown, bases broadly more yellowed, tips narrowly blackened; tibiæ and tarsi brownish black to black; claws of male bidentate, the basal spine small and more slender. Wings strongly tinged with brownish yellow, the prearcular and costal fields, together with cell Cu_1, more yellowed; stigma oval, darker brown; obliterative areas before stigma and across cell 1st M_2, the latter large and conspicuous, invading the adjacent cells R and M_3; veins brown, more brownish yellow in the brightened fields. Outer radial veins, together with M_1 and M_2, with abundant macrotrichia, M_3 with trichia on outer half, M_4 glabrous; both sections of Cu_1 with abundant trichia, the more proximal ones much longer; anal veins glabrous; prearcular anal vein with long trichia. Venation: Petiole of cell M_1 relatively long, about equal to m; cell 2nd A relatively broad for a species of *Indotipula*.

Abdominal tergites brownish yellow, the third and succeeding segments darker brown, becoming still darker on the outer segments; basal sternites light yellow. Male hypopygium (Plate 3, fig. 278) with the outer fourth of the tergite, *t*, produced into a depressed-flattened plate, its posterior border broadly emarginate, forming unusually broad lobes provided with abundant blackened spicules, midregion glabrous. Outer dististyle, *d*, elongate, beyond midlength the margin pale and submembranous, the outer end of style more or less pendant, with abundant rather short setæ; inner style short and compact, beak very large, yellow, lower beak much smaller, blackened, its surface microscopically squamose; no well developed outer basal lobe. Eighth sternite unmodified.

Habitat.—India (Kumaon).

Holotype, male, Tungnath, Pauri Garhwal, altitude 9,000 feet, June 1, 1958 (*Schmid*).

The most similar regional species is *Tipula* (*Indotipula*) *walkeri* Brunetti (*tenuipes* Brunetti), which differs in the coloration of the body and wings but especially in the structure of the male hypopygium, including the tergite and dististyles. The obliterative area in cell 1st M_2 of the wings is unusually large and conspicuous whereas it is quite lacking in *walkeri*.

TIPULA (INDOTIPULA) PUGIONIS sp. nov. **Plate 1, fig. 5; Plate 3, fig. 29.**

Size medium (wing of male about 14 millimeters); general coloration of thorax yellowish orange, præscutum only slightly patterned, pleura clearer yellow, unmarked; antennæ of male relatively long; wings strongly suffused, stigma darker; outer wing veins with abundant macrotrichia; cell M_1 deep, its petiole shorter than m; outer abdominal segments uniformly blackened; male hypopygium with the tergal lobes spiculose; outer dististyle pointed at tip, the apex with a few black spinoid setæ; inner dististyle with the beak truncate, outer basal lobe produced into a daggerlike black spine; eighth sternite with the margin membranous, with three groups of long yellow setæ.

Male.—Length, about 9 to 10 millimeters; wing, 13.5 to 14; antenna, about 5.2 to 5.4.

Female.—Length, about 13 to 14 millimeters; wing, 15 to 15.5.

Frontal prolongation of head, with the nasus, orange yellow; palpi yellowed, outer segments slightly more infuscated. Antennæ of male relatively long, as shown by the measurements; scape and pedicel yellow, flagellum black; flagellar segments elongate, the basal enlargements very small; segments slightly exceeding the longest verticils. Head orange, without vertical tubercle.

Pronotum and mesonotum yellowish orange, præscutum with three vaguely differentiated deeper orange stripes, lateral borders clearer yellow; vestiture of notum virtually lacking, including only two or three weak setæ on the præscutal interspaces; a smaller group of blackened setæ behind the root of the halter. Pleura clearer yellow, unpatterned. Halteres with stem light brown, yellowed at base, knob brownish black. Legs with all coxæ and trochanters clear yellow; femora brownish yellow, clearer yellow basally, tips narrowly blackened; tibiæ brownish black, tips narrowly more blackened; tarsi brownish black; claws of male small, simple. Wings (Plate 1, fig. 5)

strongly suffused with brown, prearcular and costal fields, together with the space between the cubital branches, more yellowed; stigma dark brown; restricted obliterative areas before stigma and across base of cell 1st M_2; veins dark brown, more yellowish brown in the brightened areas. Veins beyond cord with abundant macrotrichia of moderate length, including full series on veins M_{1+2}, M_1 and M_2, and for almost the full length of M_3 and M_4; no trichia on R_{1+2}; basad of cord, lacking on Rs, Cu_1 and anal veins; a few trichia on extreme outer end of vein M; prearcular anal vein with trichia; squama naked. Venation: Sc_2 ending at near two-thirds to three-fourths the length of Rs, longer than m-cu; cell M_1 very deep, its petiole about one-half to two-thirds m; cell 2nd A narrow.

Basal abdominal segments brownish yellow, beyond the fourth brownish black, including the eighth segment and hypopygium; in the female, tergites more extensively darkened, proximal two segments yellowed on sides, intermediate segments brownish black, with pale posterior borders, subterminal segments black; ovipositor horn yellow, basal shield blackened on proximal two-thirds. Male hypopygium (Plate 3, fig. 29) with the tergite, *t*, blackened, narrowed outwardly into a flattened yellow blade, the tip split into two rounded lobes that are provided with blackened spicules, these passing into long black setæ on outer margins. Region of ninth sternite with a loose pencil of relatively few long yellow setæ. Outer dististyle, *d*, yellow, strongly pointed outwardly, the apex and inner margin with four or five blackened spinoid setæ, more basally these becoming long normal bristles; outer or convex margin at near midlength with more abundant long black setæ, outwardly the setæ yellow, fewer but long; inner style distinctive, body yellow, beak short, broadly truncated at tip, lower beak blackened, its apex more narrowly truncate; apex of style with a few yellow setæ; outer basal lobe large, blackened, constricted at near midlength, the slightly expanded head setiferous, produced into a long dagger-like black spine. Phallosome including bladelike gonapophyses and the needlelike ædeagus. Eighth sternite, *8s*, broad, the posterior border extensively membranous, fringed with abundant long yellow setæ arranged in three groups, those of the incurved lateral groups longer and stronger than the more abundant but somewhat shorter central setæ; punctures of the latter small but very dense.

Habitat.—Sikkim.

Holotype, male, Manu, altitude 4,920 feet, May 10, 1959 (*Schmid*). Allotopotype, female. Paratopotypes, 1 male, 1 female, with the type.

Tipula (*Indotipula*) *pugionis* is quite distinct from other generally similar regional species in the structure of the male hypopygium, particularly the dististyles. The fly is most similar to species such as *T.* (*I.*) *walkeri* Brunetti, yet quite distinct. Edwards provided brief additional notes on the type of *T.* (*I.*) *fulvipennis* Walker, the preoccupied name that was re-named by Brunetti as above, and these further observations indicate differences in coloration of the body and legs, structure of the antennæ, and coloration and venation of the wings.

TIPULA (INDOTIPULA) SUBDILATA sp. nov. **Plate 3, fig. 28.**

Size medium (wing of male about 12.5 millimeters); general coloration of thoracic notum brown, pleura darkened in front, more yellowed posteriorly; wings strongly darkened, stigma dark brown; veins M_1 and M_2 with numerous macrotrichia; petiole of cell M_1 about one-half m; male hypopygium with the tergite terminating in two spiculose lobes; margin of outer dististyle expanded at near one-third the length, inner style unusually compact, without a well-developed outer basal lobe.

Male.—Length, about 10 to 10.5 millimeters; wing, 12 to 12.5; antenna, about 3.7 to 3.8.

Frontal prolongation of head yellowish brown, paler ventrally, nasus elongate; palpi yellowish brown. Antennæ with scape and pedicel yellow, flagellum black; flagellar segments subcylindrical, with very small basal enlargements, the segments slightly exceeding the longest verticils. Head with the front and cephalic end of anterior vertex orange, the remainder of vertex dark brown, with indications of a capillary darker vitta; vertical tubercle very small, indistinctly divided; occipital region vaguely yellowed.

Pronotum brown. Mesonotal præscutum with four pale brown stripes that are scarcely differentiated from the ground but indicated by slightly darker margins, lateral borders more yellowed; scutum brown on anterior half, the posterior part of each lobe more brownish yellow; scutellum yellow, the outer

end infuscated, parascutella yellowed; mediotergite obscure yellow, pleurotergite infuscated on posterior half, yellowed anteriorly; præscutal setæ exceedingly small and sparse. Propleura and mesepisternum darkened, mesepimeron and meron more yellowed. Halteres dark brown, base of stem restrictedly yellowed. Legs with coxæ obscure yellow, fore pair slightly more darkened; trochanters yellow; remainder of legs brownish black, femoral bases yellowed, more narrowly so on posterior pair; claws of male toothed. Wings strongly darkened, prearcular and costal fields more yellowed; stigma oval, darker brown; small but evident obliterative areas before stigma and across base of cell 1st M_2; veins dark brown. Veins M_1, M_2 and, in cases, M_3 with numerous macrotrichia, M_4, Cu and anals glabrous; a few strong trichia on the prearcular anal vein. Venation: Cell M_1 very deep, its petiole about one-half m or less.

Abdomen brownish yellow, intermediate tergites patterned with brown, the posterior borders narrowly pale; basal sternites yellow; subterminal segments dark brown, outer ones brownish black. Male hypopygium (Plate 3, fig. 28) with the tergite, *t*, narrowed outwardly, posterior border terminating in two subtriangular lobes that are separated by a U-shaped notch, lobes with microscopic black spinoid setæ at and near apex with normal black setæ more basad. Outer dististyle, *d*, relatively stout, strongly darkened basally, at near one-third the length with the margin strongly expanded; inner style unusually compact, beak relatively slender, pale, lower beak low, strongly blackened; outer crest and margin with strong yellow setæ; no well developed outer basal lobe. Eighth sternite unmodified.

Habitat.—Sikkim.

Holotype, male, Palam, altitude 5,100 feet, April 25, 1959 (*Schmid*). Paratypes, male, Teng, altitude 4,600 feet, May 12, 1959 (*Schmid*); male, Zomphuk, altitude 6,500 feet, October 1, 1959 (*Schmid*).

Tipula (*Indotipula*) *subdilata* is generally similar to some other regional species having darkened wings, very deep cell M_1, and setose outer wing veins, such including *T.* (*I.*) diacaena sp. nov., *T.* (*I.*) *pugionis* sp. nov., and *T.* (*I.*) *varuna* sp. nov., all differing among themselves in hypopygial characters. In the present fly, the outer basal lobe of the inner dististyle is lacking or virtually so.

TIPULA (INDOTIPULA) SUDRA sp. nov. **Plate 1, fig. 6; Plate 4, fig. 30.**

Allied to *divisa;* general coloration of præscutum brownish gray, with four stripes that are broadly margined with cinnamon brown; pleura light yellow with a conspicuous cinnamon brown area on mesepisternum; wings strongly tinged with yellowish brown, the costal border and stigma darker; outer medial veins with trichia; male hypopygium large, black; tergite conspicuously emarginate, the large lobes with blackened spicules and long conspicuous setæ; inner dististyle with the outer basal lobe strongly developed into a blackened spine; ninth sternite with two very long lobes that are tufted with long flattened setæ.

Male.—Length about 12 to 13.5 millimeters; wing 15 to 16; antenna about 4.6 to 5.

Frontal prolongation of head, including nasus, light yellow, dark brown beneath and on sides. Antennæ with scape and pedicel obscure yellow flagellum black; segments subequal to the longest verticils, basal enlargements small. Front and anterior vertex surrounding the antennæ light yellow, posterior vertex brownish gray, with a capillary blackened central vitta.

Pronotum light brown, the sides broadly light yellow. Mesonotal præscutum with four brownish gray stripes that are broadly margined with cinnamon brown, the humeral and lateral areas yellowed; scutum cinnamon brown; scutellum and postnotum orange, the former more yellowed basally. Pleura light yellow, anterior half of mesepisternum conspicuously cinnamon brown. Halteres with stem brownish yellow, knob dark brown, the tip narrowly pale. Legs with coxæ and trochanters yellow; femora brownish yellow, tips narrowly blackened; tibiæ and tarsi blackened; claws of male bidentate, having a basal tooth additional to the one at midlength. Wings (Plate 1, fig. 6) strongly tinged with yellowish brown, cells C and Sc, with the stigma, darker brown; obliterative areas before stigma and across base of cell 1st M_2; veins brown. Numerous macrotrichia on outer radial veins, excepting base of R_{1+2} in cases; M_1, M_2 and tip of M_3 with trichia. Venation: Rs longer than m-cu; cell M_1 deep, its petiole subequal to or shorter than m; cell 2nd A narrow.

Abdominal tergites dark brown, the posterior borders narrowly paler; sternites yellow, eighth and ninth segments brown-

ish black. Male hypopygium (Plate 4, fig. 30) large, brownish black. Ninth tergite, *t*, large, narrowed outwardly, terminating in two large lobes, tips rounded, with blackened spicules and more abundant long black setæ; inner margins of lobes at base incurved and slightly produced to form two small intermediate lobules. Ninth sternite, *9s*, with very strong lobes tufted with long flattened setæ to form a dense brush, the setæ subequal in length to the lobes, the more basal ones small. Outer dististyle, *d*, long and narrow, with conspicuous setæ, tip obtuse; inner style with beak relatively slender, dorsal crest small and pointed; outer basal lobe very large and conspicuous, terminating in a blackened spine or hook that bears a secondary lateral spine near base (not clearly evident in some cases and the possibility exists that these structures are asymmetrical on the two sides). Eighth sternite unmodified.

Habitat.—India (Kumaon, North Bengal, Sikkim).

Holotype, male, Pau Kal, Teri Garhwal, Kumaon, altitude 4,000 to 5,000 feet, April 21, 1958 (*Schmid*). Paratopotype, 1 male, with the type. Paratypes, male, Jaspur, Teri Garhwal, Kumaon, altitude 3,500 to 5,000 feet, April 15, 1958 (*Schmid*); male, Kurseong, North Bengal, altitude 5,455 feet, August 25, 1958 (*Camilleri*); male, Manu, Sikkim, altitude 4,920 feet, May 10, 1959 (*Schmid*).

The most similar species include *Tipula* (*Indotipula*) *divisa* Brunetti and *T.* (*I.*) *elegantula* Brunetti, which, while evidently allied, disagree in several important regards. Edwards had examined typical material of both species and has provided some further notes. It does not seem that Edwards would have overlooked the major spines of the inner dististyle characteristic of the present fly.

TIPULA (INDOTIPULA) VARUNA sp. nov. **Plate 1, fig. 7; Plate 4, fig. 31.**

Size relatively large (wing of male 14 millimeters); præscutum with lateral borders broadly yellow, disk with four brown stripes; scutellum yellow; pleura darkened anteriorly, paler behind; wings brown, prearcular and costal fields more yellowish brown; outer wing veins with abundant macrotrichia, cell M_1 deep; male hypopygium with tergite blackened, the lobes subtended by narrower lateral arms; outer dististyle long and narrow, near tip with strong black spinoid setæ, inner style

complex, outer basal lobe very large, spinous; eighth sternite unmodified.

Male.—Length, about 12 millimeters; wing, 14; antenna, about 4.

Frontal prolongation of head buffy yellow above, including nasus, brown on lower half; palpi black. Antennæ with scape obscure yellow, pedicel clearer yellow, flagellum black; flagellar segments with small but conspicuous basal enlargements with very long setæ that are subequal to or a little longer than the segments. Head brownish gray, the front and a circular area surrounding each antennal fossa yellow, bordered behind by a narrow transverse brown band.

Cervical region yellow, pronotum brown. Mesonotal præscutum with humeral and lateral borders broadly yellow, disk with four brown stripes, best indicated by darker margins, the cephalic ends of the intermediate pair more brownish yellow; interspaces grayish brown; scutum obscure yellow medially, the lobes patterned with brown, becoming brownish black laterally in front at the suture; scutellum yellow, parascutella darker; mediotergite yellow, pleurotergite darker above, the lower margin obscure yellow. Pleura with mesepisternum darkened anteriorly, the posterior part and propleura less evidently darkened, posterior pleurites more reddish yellow; dorsopleural membrane brown, paler behind. Halteres with stem infuscated, obscure yellow at base, knob brownish black. Legs with coxæ reddish yellow; trochanters yellow; remainder of legs dark brown, tarsi and tips of femora more blackened; claws of male conspicuously toothed. Wings (Plate 1, fig. 7) strongly suffused with brown, prearcular and costal fields more yellowish brown; stigma long-oval, dark brown; obliterative areas before stigma and across base of cell 1st M_2 small but conspicuous, especially the latter; veins brown. Veins beyond cord with abundant macrotrichia, including all outer branches of M, lacking on all but base of R_{1+2}, sparse on M_1; basad of cord lacking on Rs, Cu and anals, with a single trichium near tip of 1st A. Venation: Cell M_1 deep, its petiole about one-half m; m-cu close to fork of M_{3+4}; cell 2nd A relatively narrow, especially on basal half.

Abdominal tergites brown, more reddened on first segment, sternites more reddish yellow; hypopygium black. Male hypo-

pygium (Plate 4, fig. 13) with the ninth tergite, *t*, black, produced caudad into conspicuous lobes, subtended laterally by slightly shorter and more slender lobes, their outer faces with delicate setulæ, inner margins with sparse coarse setæ; outer margins of central lobes fringed with conspicuous setæ, apex and inner margin with sparse denticles; median region of ventral surface on either side produced into a blackened plate. Ninth sternite beneath on either side with a rounded lobe that is densely set with small setæ, subtended at base by a pencil of long yellow bristles. Outer dististyle, *d*, long and narrow, the base dilated, tip decurved; outer end with several strong black spinoid setæ, longer on the decurved part, outer margin of stem with numerous long normal setæ; inner style complex, the body with a small pale beak and a larger blackened lower beak, its apex microscopically roughened; immediately back from beak on outer margin with a long narrow yellow dorsal crest, paling into membrane outwardly; outer basal lobe very large and conspicuous, blackened, exceeding in area the body of the style, bilobed into a flattened inner blade and a narrower outer arm that terminates in a stout blunt spine with a further acute spine on margin. Phallosome with the apophyses appearing as narrow yellow blades, subequal in length to the slender ædeagus. Eighth sternite unmodified, with sparse setæ.

Habitat.—Sikkim.

Holotype, male, Teng, altitude 4,600 feet, May 12, 1959 (*Schmid*).

Tipula (*Indotipula*) *varuna* is readily told from the other now numerous known species of the subgenus that have cell M_1 of the wings very deep and the outer veins with trichia by the somewhat remarkable male hypopygium. Lateral arms on the tergite are likewise found in *T.* (*I.*) *palnica* Edwards, an entirely different fly in all other regards.

TIPULA (VESTIPLEX) DORON sp. nov. **Plate 1, fig. 8; Plate 4, fig. 32.**

Size medium (wing of male 15 millimeters); wings of female semiatrophied; general coloration of mesonotum gray, the præscutum with four stripes, intermediate pair darker; central region of scutellum and mediotergite broadly blackened; wings light brown, vaguely patterned with darker brown and more yellowed areas; abdomen orange yellow, basal tergites with three

very conspicuous entire black stripes, outer segments uniformly blackened; each cercus of ovipositor with two rows of small teeth; male hypopygium with posterior border of tergite broadly emarginate; appendage of ninth sternite conspicuous, narrowed to a point; outer margin of basistyle with a quadrate blackened glabrous lobe.

Male.—Length, about 14 millimeters; wings, 15; antenna, about 5.

Female.—Length, about 13 millimeters; wing, 6.5; antenna, about 2.8.

Male.—Frontal prolongation of head of moderate length, slightly shorter than remainer of head, light gray above, brownish black laterally and beneath; nasus distinct, palpi black. Antennæ with scape and pedicel yellowish brown, flagellum black; flagellar segments with strong basal enlargements, clothed with dense black setulæ; verticils shorter than the segments, outspreading, five to each segment. Head light gray, more infuscated on the genæ; central area of vertex weakly darkened, with a very conspicuous capillary black median line, extending from the very narrow elevated vertical tubercle almost to the occiput, posterior orbits more yellowed.

Pronotum gray, patterned with dark brown, scutum above with dense short black setæ. Mesonotal præscutum with the humeral region light gray, posterior interspaces more infuscated; disk with four stripes, intermediate pair darker, virtually confluent, lateral stripes gray, indistinctly margined internally with brown, outer borders narrowly darker brown; scutellum virtually covered by a black line that extends cephalad over the central part of the scutum, parascutella and remainder of scutellum light gray; mediotergite yellow pollinose, especially behind, with a large black central area, pointed posteriorly; pleurotergite more yellowed, darker above; vestiture of scutellum and mediotergite sparse and almost microscopic. Pleura yellowish brown above, clearer gray below; dorsopleural membrane dark brown. Halteres relatively short, reddish brown, the elongate knobs black. Legs with coxæ gray, the fore pair darkened anteriorly, all with long white setæ; trochanters obscure yellow to brownish yellow; femora brownish black, bases broadly more yellowed; tibiæ brown, paler basally, passing into brownish black; tarsi black, proximal end of basitarsus slightly paler;

claws of male enlarged at base, produced into small tooth. Wings (Plate 1, fig 8) with disk light brown, vaguely patterned with more yellowed areas, chiefly in the basal cells, including also a poststigmal band extending posteriorly into cell 1st M_2; slightly darker areas at arculus, origin of Rs, stigma and anterior cord, somewhat less evident in cell M and in outer radial cells; cell Sc yellow; veins brown, Sc and Cu_2 more yellowed. Squama naked; veins beyond cord with numerous small trichia, lacking on outer half of R_{1+2}, bases of M_1, M_2 and M_3, all sections of M_{1+2} and M_4; distal section of Cu_1 with trichia on central half; no trichia on Rs, M or 1st A; a strong series on more than outer half of 2nd A; a very few on prearcular section of 1st A. Venation: R_{1+2} preserved; Rs nearly twice m-cu; cell M_1 about one-third longer than its petiole.

Abdominal tergites conspicuously orange yellow, with three very conspicuous entire black stripes, the lateral ones slightly wider than the median line and about two-thirds as broad as the ground interspaces; sternites yellow, the more proximal segments weakly darkened, posterior end of sternite two and succeeding segments broadly darkened medially, more heavily so at posterior end of each segment; outer segments, including hypopygium, blackened. Male hypopygium (Plate 4, fig. 32) with the tergite, *t*, transverse, posterior border with a broad V-shaped emargination, the lobes triangular, their mesal edge straight, fringed with short black recurved setæ. Appendage of ninth sternite conspicuous, the outer end narrowed to a subacute point, outer surface with very long setæ over much of the length. Basistyle, *b*, with a quadrate blackened lobe on margin, its outer angles rounded, surface glabrous. Outer dististyle, *d*, dusky, relatively short, apex obtuse, surface with abundant short setæ, marginal ones recurved; inner style with beak conspicuous, apex obtuse, lower beak low, blackened; outer crest with abundant coarse black setæ, more numerous posteriorly. Ædeagus triangular in outline, broad at base.

Female.—Coloration as in male, showing only slight differences. Wings semiatrophied, as shown by the measurements, almost uniformly medium brown; veins slightly darker; cell M_1 longer than in *tardigrada*. Ovipositor with cerci large, both the ventral and lateral serrulations small and numerous; hypovalvæ profoundly separated at midline, the outer ends more narrowed, obtuse at tips.

Habitat.—Sikkim.

Holotype, male, Gey, altitude 11,650 feet, in *Rhododendron* association, May 18, 1959 (*Schmid*). Allotopotype, female, in copula, pinned with type.

The most similar species is *Tipula* (*Vestiplex*) *tardigrada* Edwards, of Yunnan, which has the wings of the female reduced to a comparable degree and with the general structure of the hypopygium somewhat the same. The two flies differ in the coloration, including the antennæ, body and wings, and in details of structure of the hypopygium.

TIPULA (VESTIPLEX) TANYCERA sp. nov. **Plate 4, fig. 33.**

Allied to *mitchelli;* size large (wing of male about 20 millimeters); antennæ of male elongate (about 8.5); thorax gray, præscutum with four stripes that are narrowly bordered by dark brown, the lateral stripes clear gray; wings brown, variegated by whitish and darker areas; abdomen chiefly orange yellow, tergites darkened sublaterally; male hypopygium with basistyle unarmed; tergal saucer blackened, lateral tooth far caudad, posterior border with variable crenulations; inner dististyle with a conspicuous blackened tooth at near midlength; ædeagus slender, subtended by long pale angulated gonapophyses.

Male.—Length, about 19 to 20 millimeters; wing, 20 to 21; antenna, about 8.5 to 8.7.

Female.—Length, about 22 millimeters; wing, 17.

Frontal prolongation of head brownish above, darker brown on sides; nasus stout; palpi brownish black. Antennæ of male 13-segmented, elongate; scape and pedicel yellow, flagellum black; flagellar segments beyond the first strongly incised, with conspicuous basal enlargements, the pedicels slender and sinuous, longest verticils not exceeding two-thirds the length of the segments. Head gray, yellowed on front, with a narrow dark brown capillary line extending from the summit of the entire vertical tubercle onto the posterior vertex, narrowed behind, not reaching the occiput.

Pronotum brownish gray, scutum with a narrow brown central line. Mesonotal præscutum brownish gray, with four stripes that are narrowly bordered by dark brown, lateral stripes clear

blue gray, intermediate pair duller gray; scutum with lobes chiefly covered by two confluent blue-gray areas that are bordered by brown, restricting the gray central area to a narrow line; scutellum gray with a brown median vitta; mediotergite gray with a capillary brownish black central line, pleurotergite light gray; vestiture of mesonotum short and sparse. Pleura light gray on dorsal sternopleurite, the remainder chiefly clearer blue gray; dorsopleural membrane dull yellow. Halteres with stem pale yellow, more orange at base, knob dark brown. Legs with coxæ light gray; trochanters yellow, with a dark spot beneath; femora brownish yellow, tips narrowly and inconspicuously black, the amount subequal on all legs, on posterior pair including about the outer tenth; tibiæ yellowish brown, tips narrowly more darkened; basitarsi light brown, outer segments passing into black; claws of male small, simple. Wings brown, variegated with whitened areas; prearcular and costal fields more yellowed, especially cell Sc; stigma small, brownish yellow; darker brown spots at origin of Rs, cord and two in cell R, these enclosing a more or less distinct whitened area; other major whitenings before and beyond stigma, in outer half of cell R_5 and in the broad bases of cells Cu and 1st A; obliterative area across cell 1st M_2 slightly more whitened, conspicuous; veins brown, more brownish yellow in the yellowed areas. Veins beyond cord with relatively sparse and scattered macrotrichia, lacking on R_{2+3}, R_3, all but tips of outer medial veins, and extensively lacking before cord, there being none on Rs, M or 1st A, very few on basal section of Cu_1, more numerous on outer third of 2nd A; squama naked. Venation: Rs about one-half longer than m-cu; petiole of cell M_1 subequal to or shorter than m.

Abdomen chiefly orange yellow, tergites with a broad pale brown sublateral line, more evident on the proximal segments, lateral margins buffy; outer segments slightly more darkened. Ovipositor with cerci microscopically toothed on outer two-thirds only, distinct on about the outer half, the more proximal teeth small and sparse; hypovalvæ produced into long needlelike points, separated from the truncated sides by a deep U-shaped notch, somewhat as in *pallidicosta*. Male hypopygium (Plate 4, fig. 33) with the tergal saucer *t*, heavily blackened, the acute lateral tooth far caudad; posterior margin variable as regards toothing and crenulations, two conditions being illustrated; la-

teral tooth largest, obtuse, appearing more acute when viewed from the side. Basistyle, *b*, unarmed. Outer dististyle, *d*, broad, its total length less than three times the width; inner style simple, its outer margin with a conspicuous blackened tooth, the tip obtuse. Ædeagus long and slender, subtended on either side at base by a large pale gonapophysis that is angularly bent at near midlength.

Habitat.—Pakistan.

Holotype, male, Salf-ul-Maluk Sar, Northwest Frontier Province, altitude 11,000 feet, along lake margin, July 2, 1953 (*Schmid*). Allotopotype, female, pinned with a paratopotype male. Paratopotypes, 3 males; paratypes, 5 males, Kalarian Baihk, Northwest Frontier Province, altitude 11,270 feet, along lake delta, July 13, 1953 (*Schmid*).

The most similar species is *Tipula* (*Vestiplex*) *mitchelli* Edwards, likewise from the northwestern Himalayas, differing evidently in the armature of the tergal plate, both dististyles, and the phallosome. The hypopygial details in *mitchelli* have been described and illustrated in the references cited below.*

TIPULA (OREOMYZA) FAUTRIX sp. nov. **Plate 1, fig. 9; Plate 4, fig. 34.**

Belongs to the *variipennis* group; size medium (wing of male 14 millimeters); general coloration gray, præscutum with four brown stripes, pleura slightly patterned; antennæ with basal segments yellow, flagellum black; frontal prolongation of head unusually long, without nasus; legs black, femoral bases narrowly yellow; wings yellow, variegated with light and darker brown; R_{1+2} chiefly atrophied; basal abdominal segments yellow, slightly lined with brown, outer segments black; male hypopygium with tergite emarginate, lateral lobes obtuse, glabrous at tips; phallosome with lateral apophyses elongate, each terminating in a strong reddish spine.

Male.—Length, about 13 millimeters; wing, 14 antenna, about 4.1.

Frontal prolongation of head black, pruinose, unusually long, subequal to remainder of head; no nasus; palpi black. Antennæ with scape obscure yellow, weakly patterned with brown

* Alexander, C. P., Records Indian Mus. **44** (1942) 39.
Savtshenko, E. N., Horæ Soc. Ent. Union Sovet. **47** (1960).

at either end; pedicel yellow, flagellum black, basal two-thirds of first segment obscure yellow; basal enlargements of segments small, verticils shorter than the segments. Head light gray in front, slightly infuscated behind, especially on central part; posterior orbits gray; vertical tubercle conspicuous, rounded; setæ of anterior vertex small and sparse with only about four on either side.

Pronotum gray, patterned medially and at lateral ends with dark brown. Mesonotal præscutum yellowish gray, with four brown stripes, the narrow intermediate pair only slightly wider than the median interspace, lateral stripes with the posterior end paling to gray; scutum gray, each lobe with two brown areas, the posterior one more than four times as extensive as the others, central region behind weakly darkened; posterior sclerites of notum gray, with a darker central vitta, the mediotergite further darkened sublaterally; pleurotergite gray, brighter on the katapleurotergite. Pleura yellowish gray, the propleura darkened; anepisternum, ventral sternopleurite and meron paler brownish gray; dorsopleural membrane light brown. Halteres with stem yellow, knob brownish black. Legs with coxæ buffy yellow, fore pair slightly darker; trochanters yellow; remainder of legs black, femoral bases narrowly yellowed, a little more extensively so on fore pair; claws with small tooth. Wings (Plate 1, fig. 9) with the restricted ground cream yellow, the prearcular and costal fields bright yellow, especially cell Sc; a conspicuous pale brown and darker brown pattern, including the stigma and slightly paler brown clouds at origin of Rs, anterior cord and before midlength of cells R and M; the paler brown pattern includes all cells distad of level of outer end of cell 1st M_2, there being no brightening in the outer radial and medial fields; basad of cord the yellow and pale brown areas subequal in extent; a conspicuous whitened obliterative area in bases of cells 1st M_2 and M_3, the prestigmal whitened area very small; yellow areas beyond stigma in bases of cells R_2 and R_3 relatively small, barely entering cell R_3; veins brown, yellow in the brightened fields, especially Sc, R, Cu_2 and the prearcular veins. Macrotrichia on outer radial veins and distal ends of all outer medial veins, lacking on Sc, Rs, main stems of M and Cu and 1st A; 2nd A with a few scattered trichia on central portion; prearcular veins glabrous. Venation: R_{1+2} virtually atrophied, represented by a faint basal spur; Rs about twice

the oblique m-cu; basal section of R_{4+5} reduced; m-cu on M_4 some distance beyond the origin, leaving a transverse basal section of the latter that is subequal to or only a little shorter than M_{3+4};cell 1st M_2 relatively large.

Abdomen with basal three tergites yellow, with indications of a pale brown central stripe, best indicated on posterior part, and darker sublateral lines, the margin of outer half of each segment light gray pruinose; tergite four darker, the sublateral stripe and gray border more evident; basal sternites yellow; segments five to nine black, the hypopygial dististyles pale. Male hypopygium (Plate 4, fig. 34) with the tergite, *t*, large, posterior border produced into two lobes, obtuse, tips glabrous; median area with a narrow secondary U-shaped notch, the cephalic part of tergal plate with a central furrow. Outer dististyle, *d*, simple, gradually narrowed outwardly, tip obtuse, the length of style about four times the greatest width; inner style massive, beak slender, lower beak stouter, with tip rounded, both beaks blackened; outer basal lobe pale, covered with dense pale setulæ and fewer setæ; dorsal crest almost straight, setæ unusually small and sparse. Phallosome, *p*, including two pairs of apophyses, the outer ones elongate, narrowed into a strong reddish spine, with a few microscopic appressed spinules back from tip on inner margin. Eighth sternite unmodified.

Habitat.—Sikkim.

Holotype, male, Gey, altitude 11,650 feet, in *Rhododendron* association, May 18, 1959 (*Schmid*).

The generally similar regional species include *Tipula* (*Oreomyza*) *laetabunda* Alexander, *T.* (*O.*) *ranee* sp. nov., and some others, all differing among themselves in the wing pattern and in the structure of the male hypopygium.

TIPULA (OREOMYZA) MYSTAX sp. nov. **Plate 4, fig. 35.**

Belongs to the *variipennis* group; size large (wing of male 16 millimeters); thorax gray, præscutum with four clearly defined black stripes; front of head with abundant long black setæ; antennæ relatively long, black throughout; legs black, claws simple; wings grayish brown, patterned with large whitened areas and sparse darker brown markings; veins unusually glabrous; vein R_{1+2} entire; abdomen plumbeous, tergites with a poorly indicated brownish black median stripe; male hypo-

pygium with tergite transverse, the broad obtuse lobes yellow; inner dististyle massive, the region of the outer basal lobe bluntly produced.

Male.—Length, about 15 millimeters; wing, 16; antenna, about 6.

Frontal prolongation of head black, gray pruinose, especially at base above, nasus distinct; palpi black; region of nasus, sides of the prolongation and front before the antennal bases with abundant black setæ of unusual length. Antennæ black throughout; flagellar segments slightly incised beyond the small basal enlargements; verticils very short and inconspicuous, scarcely as long as the diameter at the point of their insertion. Head dark brown.

Pronotum brownish black. Mesonotal præscutum light gray, with four clearly defined black stripes, the intermediate pair divided by a broad brownish gray line that is about equal in width to the stripes at near their midlength; scutum blue-gray, center of each lobe with a single black area; scutellum dark gray, parascutella brownish black; mediotergite light gray in front, brownish black behind, pleurotergite gray above, darker posteriorly behind. Pleura gray. Halteres with stem light brown, knob brownish black. Legs with coxæ gray; trochanters brownish gray; remainder of legs entirely black; claws simple. Wings grayish brown, patterned with large whitened areas and about three darker brown spots, the largest at origin of Rs, stigma and over the anterior cord; the pale areas are in the bases of cells R and M, continued backward into cells Cu and 1st A; before and beyond origin of Rs, the latter larger; at near two-thirds the length of cell M; post-stigmal, extending posteriorly into cell R_3; in cells 1st M_2 and base of cell M_3, and two marginal areas in cell 1st A; cell Sc more uniformly light yellow; veins brown. Veins unusually glabrous, beyond cord with a few trichia on distal section of R_{4+5}, none on the remaining veins. Venation: R_{1+2} entire; petiole of cell M_1 a trifle shorter than m; m-cu on M_4 beyond the short vertical base.

Abdominal tergites plumbeous, segments one to three with a vaguely differentiated brownish black median stripe, broadly interrupted at the posterior margins; lateral tergal borders paling to buffy; sternites darker plumbeous; hypopygium, excepting the outer appendages, black. Male hypopygium (Plate 4, fig. 35)

with the tergite, *t*, transverse; posterior border with two broad yellow lobes that are separated by a U-shaped notch that is produced caphalad into a dorsal furrow; lobes with very small pale setæ additional to a group of about four or five black setæ near outer lateral end, margins microscopically crenulate. Basistyle complete, the ventral end with a close group of long yellow setæ that are directed ventrad. Outer dististyle, *d*, flattened, broadest before midlength, gradually narrowed to the obtuse tip; inner style massive, both beaks blackened, obtuse, particularly the lower beak; region of outer basal lobe farther produced into a bluntly obtuse to triangular lobe. Gonapophyses, small, simple. Eighth sternite unmodified.

Habitat.—Sikkim.

Holotype, male, Chumzomoi Choka, altitude 11,800 feet, in *Rhododendron* association, July 8, 1959 (*Schmid*).

Tipula (*Oreomyza*) *mystax* is readily told from other regional members of the *variipennis* group by the large size, coloration of the body, legs and wings, and especially by the unusual development of setæ on the front, suggesting the specific name. It should be noted that virtually all of the other regional members of the group have vein R_{1+2} chiefly or entirely atrophied, such including *T.* (*O.*) *camillerii* Alexander, *T.* (*O.*) *fautrix* sp. nov., *T.* (*O.*) *laetabunda* Alexander, *T.* (*O.*) *ranee* sp. nov. and *T.* (*O.*) *striatipennis* Brunetti.

TIPULA (OREOMYZA) RANEE sp. nov. **Plate 1, fig. 10.**

Size medium (wing of female, 12.5 millimeters); general coloration of thorax gray; præscutum with four brown stripes; antennæ with scape and pedicel light yellow, flagellum black; narrow dark central stripes on head and on posterior sclerites of mesonotum; femora with a yellow subterminal ring; wings whitened, heavily patterned with brown, cells C and Sc light yellow; a nearly complete white crossband beyond cord; tip of vein R_{1+2} atrophied or subatrophied; cell M_1 deep; lateral borders of abdominal segments narrowly silvery.

Female.—Length, about 13 millimeters; wing, 12.5 antenna, about 2.6.

Frontal prolongation of head of moderate length, grayish yellow above, lower half dark brown; nasus long, light yellow. Antennæ with scape and pedicel light yellow, flagellum black;

flagellar segments (female) elongate, a trifle exceeding the longest verticils. Front and vertical tubercle buffy yellow, posterior part of head brownish gray, with a capillary dark brown median vitta.

Pronotum gray, patterned with brown, narrowly but intensely so at midline of scutum. Mesonotal præscutum light gray, with four brown stripes, the intermediate pair obsolete at their anterior ends, relatively narrow, separated by a ground line of about one-half their width; lateral stripes narrower and paler; pseudosutural foveæ reduced to a circular black spot; posterior sclerites of notum light gray, scutal lobes with two brown areas, the posterior one large and distinct; scutellum and mediotergite with a central brown vitta, pleurotergite more infuscated. Pleura gray, dorsopleural membrane light brown. Halteres with stem yellow, knob dark brown. Legs with coxæ yellowish gray; trochanters yellow; femora yellow basally, passing into dark brown, with a broad and conspicuous yellow subterminal ring on all legs; tibiæ and basitarsi light brown, tips darker, remainder of tarsi passing into dark brown. Wings (Plate 1, fig. 10) with the restricted ground white, heavily patterned with brown; prearcular field and cells C and Sc light yellow; white ground areas before and beyond origin of Rs, narrowly interrupted, and beyond midlength of cell M; a nearly complete band beyond cord, virtually crossing the wing, nearly interrupted in cell 1st M_2 and again at posterior margin; pale areas in cell Cu and outer half of cell R_5; a common are anear bases of cells Cu and 1st A; bases of both anal cells, two small spots at outer end of cell 1st A, with a still smaller one in cell 2nd A; veins brown, Sc clear light yellow. Abundant macrotrichia on veins beyond cord, including R_3, R_{1+5} and distal ends of outer medial veins; Sc and anal veins glabrous. Venation: Tip of R_{1+2} atrophied in one wing of type, entire but paler in the other wing; Rs long, nearly three times m-cu; cell M_1 very deep, its petiole about one-third m; basal section of vein M_4 perpendicular, relatively long.

Abdomen evidently discolored, tergites apparently obscure yellow, with a brown central stripe; lateral borders of both tergites and sternites narrowly but conspicuously silvery, these areas bordered internally by dark brown; basal sternites yellow, the outer ones darker. Ovipositor with cerci long and slender, nearly straight; dorsal shield dark brown.

Habitat.—India (Kumaon).

Holotype, female, Kulara, Pauri Garhwal, altitude 12,000 feet, August 3, 1958 (*Schmid*).

This attractive fly is most nearly allied to *Tipula* (*Oreomyza*) *camillerii* Alexander and *T.* (*O.*) *striatipennis* Brunetti, among the described regional species. It is readily told from these and others by the coloration of the body, legs and wings.

ILLUSTRATIONS

[Legend: *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite.]

Plate 1

Fig. 1. *Tipula* (*Schummelia*) *lioterga* sp. nov.; venation.
2. *Tipula* (*Schummelia*) *penicillaris* sp. nov.; venation.
3. *Tipula* (*Acutipula*) *triplaca* sp. nov.; venation.
4. *Tipula* (*Indotipula*) *diacæna* sp. nov.; venation.
5. *Tipula* (*Indotipula*) *pugionis* sp. nov.; venation.
6. *Tipula* (*Indotipula*) *sudra* sp. nov.; venation.
7. *Tipula* (*Indotipula*) *varuna* sp. nov.; venation.
8. *Tipula* (*Vestiplex*) *doron* sp. nov.; venation.
9. *Tipula* (*Oreomyza*) *fautrix* sp. nov.; venation.
10. *Tipula* (*Oreomyza*) *ranee* sp. nov.; venation.
11. *Ctenacroscelis perobtusus* sp. nov.; male hypopygium.
12. *Ctenacroscelis nirvana* sp. nov.; male hypopygium.

Plate 2

Fig. 13. *Tipula* (*Bellardina*) *arjunoides* sp. nov.; male hypopygium.
14. *Tipula* (*Bellardina*) *lithostrota* sp. nov.; male hypopygium.
15. *Tipula* (*Bellardina*) *oenone* sp. nov.; male hypopygium.
16. *Tipula* (*Bellardina*) *schmidiana* sp. nov.; male hypopygium.
17. *Tipula* (*Schummelia*) *lioterga* sp. nov.; male hypopygium.
18. *Tipula* (*Schummelia*) *nobilior* sp. nov.; male hypopgium.
19. *Tipula* (*Schummelia*) *penicillaris* sp. nov.; male hypopygium.
20. *Tipula* (*Acutipula*) *indra* sp. nov.; male hypopygium.

Plate 3

Fig. 21. *Tipula* (*Acutipula*) *kumpa* sp. nov.; male hypopygium.
22. *Tipula* (*Acutipula*) *sicula* sp. nov.; male hypopygium.
23. *Tipula* (*Acutipula*) *triplaca* sp. nov.; male hypopygium.
24. *Tipula* (*Anomaloptera*) *bathroxantha* sp. nov.; male hypopygium.
25. *Tipula* (*Anomaloptera*) *xanthocera* Alexander; male hypopygium.
26. *Tipula* (*Indotipula*) *diacæna* sp. nov.; male hypopygium.
27. *Tipula* (*Indotipula*) *gupta* sp. nov.; male hypopygium.
28. *Tipula* (*Indotipula*) *subdilata* sp. nov.; male hypopygium.
29. *Tipula* (*Indotipula*) *pugionis* sp. nov.; male hypopygium.

Plate 4

Fig. 30. *Tipula* (*Indotipula*) *sudra* sp. nov.; male hypopygium.
31. *Tipula* (*Indotipula*) *varuna* sp. nov.; male hypopygium.
32. *Tipula* (*Vestiplex*) *doron* sp. nov.; male hypopygium.
33. *Tipula* (*Vestiplex*) *tanycera* sp. nov.; male hypopygium.
34. *Tipula* (*Oreomyza*) *fautrix* sp. nov.; male hypopygium.
35. *Tipula* (*Oreomyza*) *mystax* sp. nov.; male hypopygium.

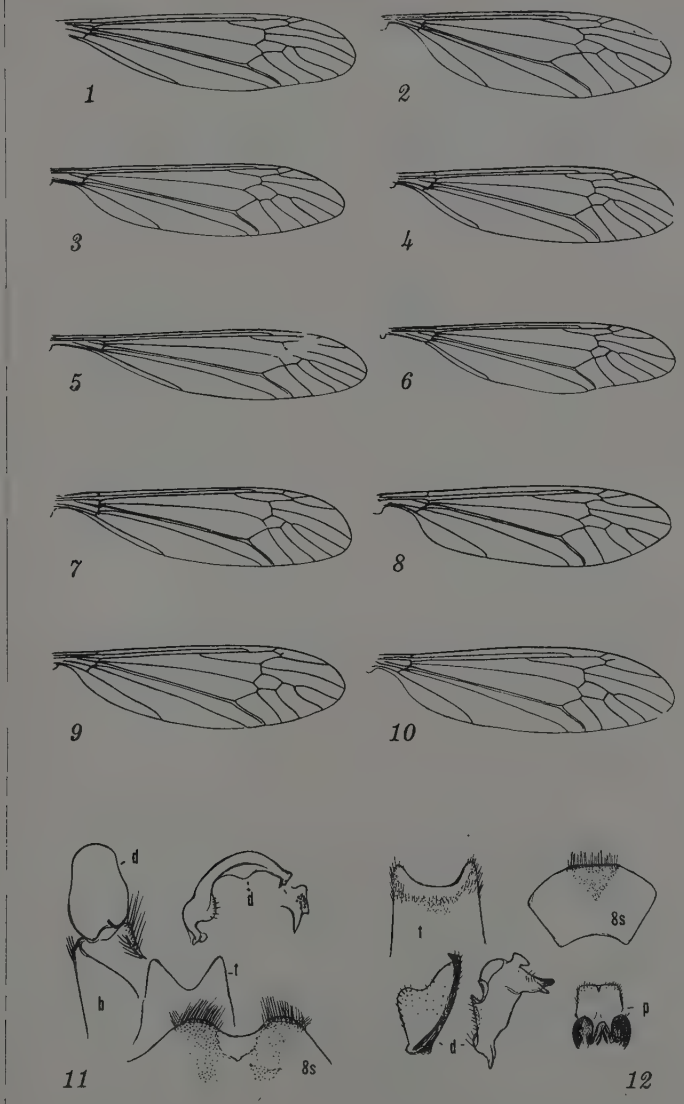

PLATE 1.

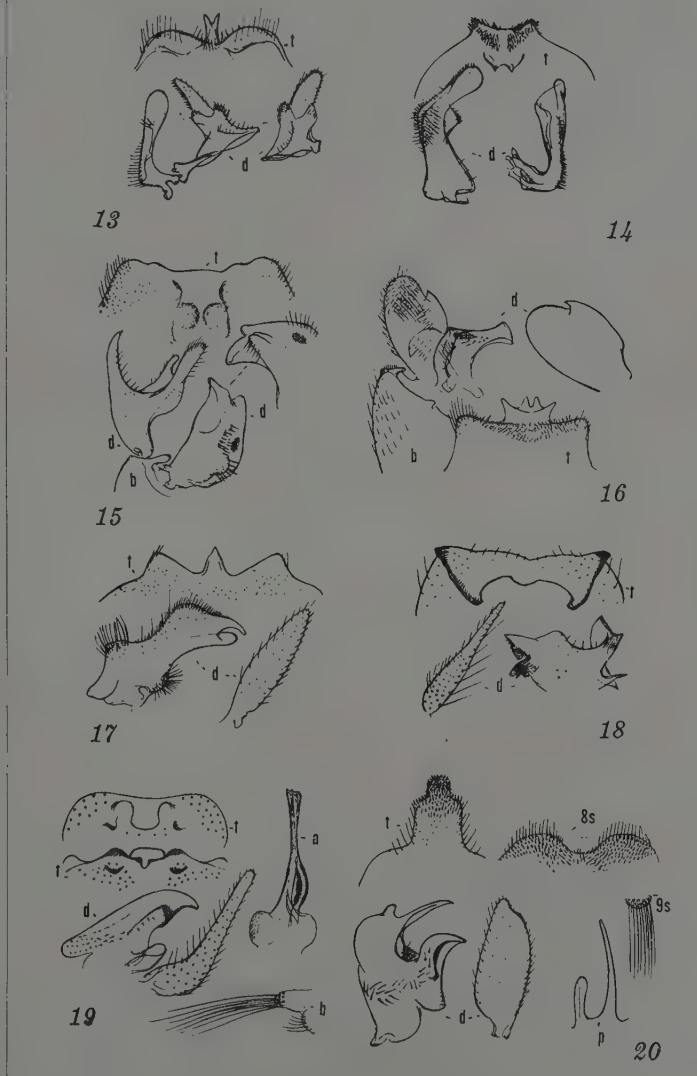

PLATE 2.

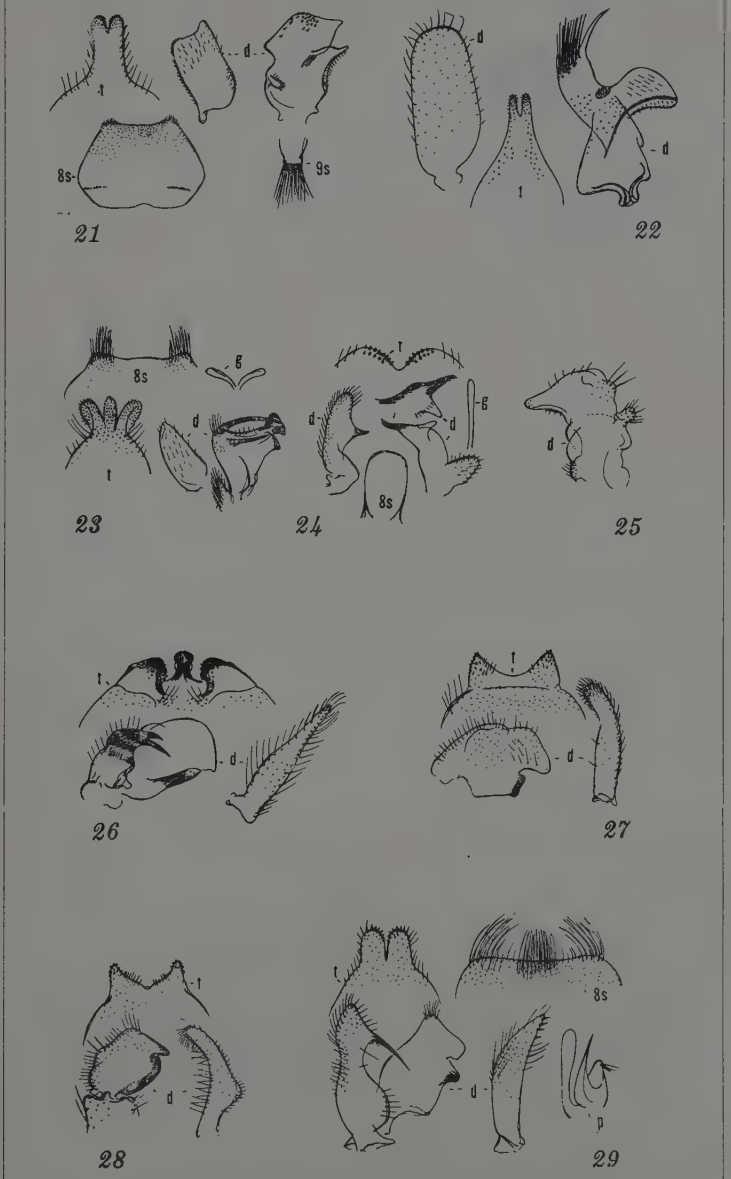
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PLATE 3.

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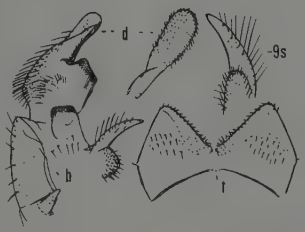

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PLATE 4.

BOOK REVIEWS

Books reviewed in this section represent a selection from those received from time to time by the National Institute of Science and Technology and the Philippine Atomic Energy Commission, two sister agencies under the National Science Development Board.

Principles of Electricity and Magnetism. By Emerson M. Pugh and Emerson W. Pugh. Reading, Mass. & London, Addison-Wesley Publ. Co., Inc. 1960. xi, 430p. Price $6.50.

Emerson M. Pugh, father and son, both doctors of science at the Carnegie Institute of Technology and both connected with industrial laboratories, are the joint authors of this very illuminating textbook on electricity and magnetism.

Designed for a two-semester course for advanced undergraduate students, it provides an understanding of the principles of electricity and magnetism essential for all technical fields and discusses Maxwell's four-field relations and the Lorentz force-on-a-charge equation concisely and rigorously. These equations are useful because they are expressed in vector notation. Students who have little or no knowledge of vectors will not find this a stumbling block as they will be guided by discussions of the principles of vector algebra and calculus, which are treated at the beginning and then used throughout the text.

Difficult concepts are simplified and special emphasis has been given to the discussions of transmission of energy from an emitter of electromagnetic energy to an absorber from the low frequencies of ordinary power transmission to the ultra-high frequencies of radar. The galvanometer is also treated with considerable detail owing to its importance in many applications and because it provides good illustrations for several fundamental principles.

The subjects are organized in 11 well-written chapters, about half of which number dealing with vector mathematics, electrostatic fields, solution of electrostatic problems, electromagnetic radiation, dielectric materials, and magnetic materials. They are clearly discussed with appropriate illustrative materials and definitions and, to determine the student's progress, problems were appended and answers provided at the end of the book.

There is no doubt about the importance of the book to all students of physics and technology. Understandingly, the authors have made it accessible to schools with tight curricula by designating such few chapters and sections which may be dispensed with in a one-semester course for students having less time but possessing higher academic backgrounds in mathematics.—A.G.

Foundations of Electromagnetic Theory. By John R. Reitz and Frederick J. Milford. Reading, Mass. & London, Addison-Wesley Publ. Co., Inc., 1960. xi, 387p. Price $6.50.

Classroom experience of the authors in the teaching of electricity and magnetism to physics majors, at the Case Institute of Technology, enabled them to see the need for a good textbook on the subject for advance undergraduates of physics and mathematics. The outcome of their joint efforts along this line is the present well-written book.

Students who have been introduced to vector analyses, partial differential equations in physics, and boundary-value problems can now further develop these mathematical concepts with the materials presented in the book. It contains, among others, a full vector treatment of electricity and magnetism, a utilitarian approach to boundary-value problems, a rigorous discussion of the development of electricity and magnetism from experimental laws, and an introduction to plasma physics.

All its 17 chapters give a thorough study of their subjects and carry all such information as are invaluable to both the science specialist and the advanced undergraduate. To accommodate the requirements of a brief college course certain sections are marked for deletion to effect brevity without loss of continuity. As in the other books in the Addison-Wesley series in physics, each chapter is appended by copious problems for solution, half of which are answered for the checking of results.—A.G.

Introduction to Statistical Thermodynamics. By Terrell L. Hill. Reading, Mass. and London, Addison-Wesley Publ. Co., Inc., 1960. xiv, 508p. Price $9.75.

This book is an introductory textbook on equilibrium statistical mechanics recommended for courses in postgraduate level majoring in physics or chemistry. It is assumed that the reader must have an advance knowledge of calculus, thermodynam-

ics, elementary differential equations, and elementary quantum mechanics.

The book is divided into four parts: Part I deals with principles of quantum statistical mechanics, Part II with the applications of these principles, Part III with problems which arise when molecules can no longer be treated as independent of each other because of intermolecular forces, and Part IV with problems for which the classical limit is not valid.

Suggestions are given in the preface for adopting the book as a text for either a one- or two-semester graduate course in chemistry or a one-semester graduate course in physics. Solution of problems and exercises at the end of each chapter will help the student clarify the subject matter.—J.G.A.

Geometry. By Charles F. Brumfiel, Robert E. Eicholz, and Merrill E. Shanks. Reading, Mass. and London, Addison-Wesley Publ. Co., Inc., 1960. xii, 288p. Price $4.75.

This book represents an earnest effort to fill in the logical gaps in Euclid's presentation of plane geometry.

Besides mathematical completeness, an attribute that makes for clarity and ease of understanding, the book has topics which are not commonly found in most textbooks in geometry. These consist of chapters on analytic geometry, locus, solid geometry and philosophy of mathematics, which provide supplementary material beyond the standard course. The chapter on logic is of great value to nonscience students and teachers because logic is used repeatedly in order to clarify the principles underlying deductive proof.

The presentation of the postulates in groups results in clarity and simplicity. Definitions are given explicitly and formally labelled as such to make the students see that precise definitions are necessary for proof.

A review of the important concepts are found at the end of each chapter. There are also algebra review sections which are designed not only to refresh skills but also to bring out the logical structure of algebra. The appendix lists all the postulates as well as the principal definitions and theorems.

This book is highly recommended as a reference book for students of plane geometry.—N.Q.P.

Algebra I. By Charles F. Brumfiel, Robert E. Eicholz, and Merrill E. Shanks. Reading, Mass. and London, Addison-Wesley Publ. Co., Inc., 1961. xi, 371p. Price $4.75.

The book presents algebra in such a way that the reasons for the different algebraic processes are made evident. The approach to the problems is directly by the postulational method, in which properties of numbers familiar to students with a background in arithmetic are postulated. The gradual and successive extensions of the number system and repeated contact with the same set of postulates make the students easily appreciate and and understand the rules of algebra.

An important feature of the text is the full chapter on logic, which helps clarify the mathematics and the nature of proof. Definitions are given explicitly and used in proofs.

The appendices contain a review of the postulates and exercises for drill material for students.—N.Q.P.

Fundamentals of Mathematics. By Elbridge P. Vance. Reading, Mass. and London, Addison-Wesley Publ. Co., Inc., 1960. 469p. Price $5.50.

The text is an integrated course which combines the fundamental ideas of algebra, trigonometry, analytic geometry and elementary calculus. The range of material is both broad and varied. It is an excellent source-book of college mathematics and is suited for any student, whether he intends to pursue a course in mathematics and engineering or not.

The presentation of the subject matter in any chapter is very simple. Numerous examples and illustrations are found throughout to emphasize the basic concept by which the solution is arrived at. The author has been successful in blending the topics discussed from one chapter to another so that the continuity of ideas is preserved. The reader easily acquires a mastery of the material presented as well as a good foundation in college mathematics.—A.M.C.

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